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## CONTENTS

### Original Communications

Treatment of Extremities Following Sudden Failure of Circulation. Gordon Murray, M.D., J. S. Simpson, M.D., and N. A. Watters, M.D., Toronto, Canada ... 315
Gangrene Following Fracture Treated With Heparin, Papaverine, and Intermittent Venous Occlusion. Jay McLean, M.D., and A. Beaumont Johnson, M.D., Columbus, Ohio ... 324
Hydronephrosis. IV. The Surgical Treatment. Frank Hinman, M.D., San Francisco, Calif. ... 337
A Method for the Chemical Production of a Prolonged Sympathetic Paralysis. Major Theodore B. Rasmussen and Captain Alfred A. Alessi, Medical Corps, Army of the United States ... 360
Tenon and Mortise Grafts for Bridging Metacarpal Defects Due to Gunshot Wounds. Lieutenant Colonel Harry D. Morris, Medical Corps, Army of the United States ... 364
Two Unusual Cases of War Wounds of the Heart. Lieutenant Colonel Paul C. Samson, Medical Corps, Army of the United States ... 373
The Effect of Atropine on the Gastric Secretion Following Thermal Trauma. H. Necheles, M.D., Ph.D., E. Prescott, and William H. Olson, Chicago, Ill. ... 382
Bilateral Popliteal Hernia. Allan E. Sachs, M.D., and Lawrence Rubinstein, M.D., Chicago, Ill. ... 385
Closure of the Colostomy Stoma. Major R. O. Gregg and Captain J. M. Mosely, Medical Corps, Army of the United States ... 388
Experiments in Ulcerative Enteritis. E. S. Sinaiko, M.D., and H. Necheles, M.D., Ph.D., Chicago, Ill. With the Assistance of V. J. Greene ... 395
The Split-Thickness Skin Graft as a Covering Following Removal of a Fingernail. Edward M. Hanrahan, M.D., Baltimore, Md. ... 398

### Recent Advances in Surgery

Actinomycosis. Fred Kolouch, M.D., and Leonard F. Peltier, M.D., Minneapolis, Minn. ... 401

### Review of Recent Meetings

Meeting of the American Surgical Association. J. Dewey Bisgard, M.D., Omaha, Neb. ... 431

### Book Reviews

Book Reviews ... 442

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# Review of Recent Meetings

## MEETING OF THE CENTRAL SURGICAL ASSOCIATION

FEB. 22-23, 1946, CHICAGO, ILL.

HENRY K. RANSOM, M.D., ANN ARBOR, MICH.

*(From the Department of Surgery, University of Michigan)*

THE Third Annual Assembly of the Central Surgical Association was held at the Drake Hotel in Chicago, Ill., Feb. 22-23, 1946. Preceding the meeting, on February 21, a clinic day was held at the invitation of the University of Chicago Clinics and the Northwestern University Medical School. The morning was spent at the Billings Hospital where operative clinics and clinical demonstrations were given by members of the staff. In the afternoon a series of short papers and demonstrations was presented by the Northwestern University Medical School Staff at Thorne Hall. There was a large attendance and the programs were excellent.

Fifty-five papers were listed on the scientific program, many of which appear elsewhere in this issue of the JOURNAL. Papers published in full are not abstracted in this report.

1. **Jacob K. Berman** and **J. Paxton Powell,** Indianapolis, Ind.: **Mediastinal Tumor.**—The incidence, pathology, signs, and symptoms of mediastinal tumors and cysts were discussed, and a convenient classification of these lesions was presented. In addition to the usual examinations, the following special studies were recommended: (1) roentgenograms and fluoroscopic examination, (2) bronchography, (3) partial pneumothorax and thoracentesis. The roentgen findings of importance are: (a) position of the tumor which may give a clue to diagnosis, (b) presence of shadows indicating teeth or bone indicative of a dermoid or teratoma, (c) evidence of compression of the spine, (e) presence of pulsation of the mass, and (f) the effect of x-ray treatment on the size of the mass. A case of an enormous mediastinal teratoma occurring in a 15-year-old boy was reported. The tumor was successfully removed by thoracotomy.

2. **August F. Jonas,** Omaha, Neb.: **Massive Organizing Hemothorax.**—(See p. 168.)

*Discussion:* **William Tuttle,** Detroit, Mich., stated that he believed that many of these cases can be decorticated much later than three weeks. In his experience patients in whom decortication was done late were operated upon quite as easily as those in whom it was done after three weeks. He agreed that the proper time is probably three weeks but his reason for this was that the incidence of eventual empyema is markedly cut down by the earlier operation. Cultures of the peel that was removed from the lung were made in all cases and in about 95 per cent the cultures were positive. He felt that the group of cases which first appear to have an organizing hemothorax and later clear up does not have an organizing hemothorax but rather a hemothorax which has driven the lung down. The enfolded portion of the lung then becomes atelectatic and gives the appearance of pleural induration due to fluid. He emphasized the point that decortication must be well done. If poorly done, it is worse than no decortication at all and he stressed the importance of freeing the lung in all directions at the time of operation. **Jonas** stated that he had done decortication as late as eleven weeks after injury but that in his hands the late operation was more difficult. He also mentioned the fact that in decortication, seldom is any of the parietal peel removed. It is difficult to reach toward the apex and around the base, and its removal results in troublesome bleeding.

Received for publication, May 28, 1946.

3. **J. Dewey Bisgard,** Omaha, Neb.: **Congenital Eventration of the Diaphragm.**—Eventration of the diaphragm was discussed in its more general aspects and a case was presented in which a large eventration was observed in a small infant. This was treated surgically using a transthoracic approach with a good end result.

4. **Conrad R. Lam,** Detroit, Mich.: **Further Experiences in the Surgical Treatment of Congenital Atresia of the Esophagus With Tracheo-Esophageal Fistula.**—(See p. 174.)

5. **I. Darin Puppel,** Columbus, Ohio: **Early Diagnosis in Radical Resection of Carcinoma of the Lower Esophagus.**—Too many patients with carcinoma of the lower end of the esophagus or upper end of the stomach are seen in an advanced stage of the disease when the chance for cure by any form of therapy is slight. The importance of early diagnosis of these lesions was stressed and more frequent esophagoscopic examinations recommended. The miserable existence of most patients treated by palliative gastrostomy was discussed and a plea made for a careful appraisal of all patients presenting such lesions with regard to the possibility of transthoracic resection. The latter procedure offers the best form of palliation and a chance for cure. One case of epithelioma of the lower esophagus was presented and one of adenocarcinoma of the fundus of the stomach which had been successfully removed by the transthoracic approach with esophagogastrostomy.

6. **Frank R. Peterson,** Iowa City, Iowa: **Transplueral Esophagogastrostomy in the Treatment of Cardiospasm.**—The symptoms of cardiospasm for which the patient seeks relief are those of partial or complete obstruction occurring intermittently or persistently. The symptoms can be relieved in over 85 per cent of the cases by passing a hydrostatic dilator partially through the cardiac ring and dilating the cardia. A small group of patients, approximately 15 per cent, will fail to receive permanent benefit from such treatment and more radical procedures become necessary. Results in ten such cases with treatment by esophagogastrostomy were presented. Nine of these patients were operated upon by the transpleural route and one transperitoneally. The plastic procedure employed consisted of an incision across the cardiac ring and extended adequately into the stomach and the esophagus, followed by closure of the defect at right angles to the line of incision. Details of pre- and postoperative care were given. There were no deaths in the series and the end results were good. Peterson expressed his preference for the transpleural approach in performing this plastic procedure.

*Discussion:* **Roscoe Graham,** Toronto, Canada, stated that in his experience the Finney type of pyloroplasty carried out below the diaphragm for cardiospasm has given disappointing results. **I. Darin Puppel,** Columbus, Ohio, mentioned that in certain cases for anatomic reasons it would be impossible to mobilize the esophagus to any extent by the transperitoneal route and that in such instances the operation would be exceedingly difficult if performed from below. **Gordon Murray,** Toronto, Canada, mentioned the fact that if one uses the abdominal approach, mobilization of the esophagus is facilitated by dividing the left vagus nerve which lies anteriorly and, if this does not suffice, the right nerve posteriorly may also be divided. **Peterson** stated that he preferred the supradiaphragmatic approach for esophagogastrostomy for pylorospasm because in certain instances a constriction occurs some distance above the esophagogastric junction and this would be difficult to deal with by an abdominal approach. He believed that the danger of infection, even though contamination occurs, is less when the thoracic route is employed.

7. **J. J. Smyth** and **M. G. Gillespie,** Duluth, Minn.: **Postoperative Pulmonary Embolism.**—(See p. 180.)

*Discussion:* **Gordon Murray,** Toronoto, Canada, discussed some of his experiences in relation to the use of heparin. He endorsed early exercising in bed and early rising. When a patient has had one pulmonary embolism he will probably develop a second one and then the likelihood of death is great. He recommended the use of heparin for patients who have had one embolism and in his experience the results of such treatment have been good. He did not believe that vein ligation was the answer to the problem. **Conrad Lam,**

Detroit, Mich., presented the experience at the Henry Ford Hospital where, during the past five years, there had been just as many cases of fatal pulmonary embolism following the use of heparin as in the earlier period before the drug was employed. He felt that the difficulty lies in the proper selection of cases for heparin and believed that early ambulation may partially solve the problem since it is applicable to practically all patients. **Jacob K. Berman,** Indianapolis, Ind., stated that he could not see the rationale of vein ligation. One of his objections to this method was the thrombus which is necessarily present at the proximal end of the divided vein. He stressed the importance of anatomic incisions and early rising and condemned long, deep anesthesia which results in prolonged somnolence following operation. **Walter W. Carroll,** Chicago, Ill., discussed the advantages of phlebography and described briefly a technique which he had found most satisfactory. He believed that the information obtained by this examination is very accurate and is of great value in the selection of veins for ligation. **Roscoe Graham,** Toronto, Canada, stated that he and his associates had performed no vein ligations in the past two years and had used heparin and dicumarol in only one case. There had been no cases of fatal pulmonary embolism and he believed that the explanation was to be found in early rising. He cited as an example the high mortality in gastric operations when patients were transferred directly from the medical wards to the surgical wards without becoming ambulatory before operation, whereas those patients who were discharged from the hospital for a short period before returning for surgery had less complications of this type.

8. **F. D. Dodrill,** Detroit, Mich.: **Lung Abscess With Special Reference to Penicillin Failures.**—It was pointed out that the treatment of lung abscess by penicillin alone is doomed to failure in many instances. Often the symptoms, clinical findings, and roentgen findings disappear under this type of therapy. However, when the bronchial tree is injected with lipiodol a persistent cavity may be demonstrated. The factors responsible for penicillin failure in lung abscess are the large amount of necrosis present in the wall of the cavity, the considerable fibrosis present, and also the avascularity in this region of the lung, all of which prevent the medication from reaching the diseased tissues in sufficient concentration. Even when the drug is administered by inhalation, the same factors still obtain. Twelve patients with lung abscess previously treated with penicillin and not cured were reported upon. Two cases terminated fatally before surgery could be carried out. One patient refused operation and the other nine patients were cured by some type of surgical procedure. The surgical procedures ranged from rib resection and drainage of the cavity to a double lobectomy. In the nine patients operated upon, it was noted that in five no visceroparietal adhesions were present. It was believed that the prolonged administration of penicillin had some effect in the prevention of adhesions or possibly their early absorption and that this may represent an untoward effect of penicillin therapy. Dodrill concluded that the surgeon should evaluate each case of lung abscess, decide upon the surgical procedure indicated, and carry out that operation under the protection of penicillin as soon as the patient's condition permits.

*Discussion:* **R. M. Janes,** Toronto, Canada, stated that he believed that the ordinary type of pneumonia is very rarely followed by lung abscess and that in most cases of lung abscess a careful history will reveal that the onset was different from that of the ordinary pneumonia. In his opinion, the most efficient way of conducting postural drainage in lung abscess is to maintain the patient in a head-low position in the bed constantly. This results in continuous drainage of the abscess and is more efficient. He emphasized the importance of breathing exercises in the prevention of serious disability following chest injuries and following many chest operations. **Dodrill** stated that he felt that when an abscess cavity is in the extreme upper portion of the upper lobe of the lung, postural drainage retards rather than accelerates drainage and he prefers the sitting position of the patient in such cases. He emphasized the importance of early drainage of lung abscesses once the diagnosis is made. He explained that it was his feeling that lung abscesses are not the aftermath of pneumonia but rather represent a primary disease, the process beginning as a necrotizing bronchial lesion and later spreading to the surrounding parenchyma.

9. **Francis M. Woods** and **Edward J. McGrath**, Cincinnati, Ohio: **Management of Pulmonary Abscess.**—(See p. 187.)

*Discussion:* **Anthony Curreri,** Madison, Wis., emphasized the importance of adequate and constant drainage in the treatment of lung abscess. He felt that in the conservative treatment of this condition postural drainage and penicillin were most important. He believed that postural drainage as usually carried out is ineffective. He emphasized that postural drainage must be carried out six to eight times daily, beginning with a period of about two minutes and gradually increasing to fifteen minutes to one-half hour each time. He stressed the importance of having the patient's hips placed at the edge of the bed in order to secure adequate drainage. He felt that if improvement does not take place at the end of two weeks, surgical therapy should be instituted. In his experience drainage of simple abscesses had given fairly good results. When multilocular abscesses are present, associated with hemorrhage or abscesses, pulmonary resection is indicated.

10. **Arthur B. McGraw**, Detroit, Mich., and **Howard C. Jackson**, Kalamazoo, Mich.: **Penicillin Sterile Empyema.**—Jackson related the experience in a large United States Naval Training Center where, during the winter of 1944 and 1945, approximately 1,000 patients with pneumonia were treated with penicillin. In this group 250 developed pleural effusion. In only 5 of the 250 did penicillin and thoracentesis fail to cure the pleural effusions and these cases required open thoracostomy. The predominating organisms were streptococci. From an analysis of these five cases it was felt that it is inadvisable to delay surgical treatment of suppurative pleurisy when the recurring exudate rapidly becomes sterile with penicillin therapy, remains sterile and does not thicken quickly or the patient resumes an appearance and freedom from symptoms simulating normal health. The operative findings revealed large, single loculations of sterile purulent fluid. In the fluid were large curdy flocculent masses of fibrin. The visceral and parietal pleura were thickened and indurated, thus making the repeated thoracenteses therapeutically ineffective. All of these five patients were ill for over six months and all developed some degree of chest deformity which might have been prevented by earlier surgical intervention. Open thoracostomy was suggested as the procedure of choice if penicillin and aspirations have not resulted in healing in four weeks.

*Discussion:* **Charles McLaughlin**, Omaha, Neb., related similar experiences when in two Naval Hospitals only 34 patients of 1,200 with pneumonia developed a persistent effusion and eventually required surgical drainage. These patients were treated first by sulfonamides alone and followed an almost identical pattern with those subsequently treated by penicillin. He agreed with Jackson's conclusions. **McGraw** stated that at Bainbridge the patients treated by the sulfonamides followed a course which more like that of patients in the pre-sulfonamide days than was the case when patients were treated by penicillin.

11. **W. A. Altemeier,** Cincinnati, Ohio: **Acute Secondary Parotitis.**—(See p. 191.)

12. **W. H. Cassels,** Chicago, Ill.: **Anesthesiology; The Surgeon's Responsibility.**—It was pointed out that many forms of medical treatment involve certain hazards. This is particularly true of surgical operations where a certain small risk is justified in anticipation of the benefit to be derived thereby. While it is customary for the specialist in medicine or surgery to spend a number of years in intensive training for his lifework, this has not been true in the field of anesthesiology. The administration of an anesthetic agent involves certain hazards due to lack of sufficient oxygen, depression of respiration, obstruction of respiration, aspiration of foreign substances, convulsions, and shock. Death may occur even from the effects of anesthetics. The majority of anesthetics in this country are administered by nurse technicians who have been trained only in the technique of anesthesia and who lack sufficient knowledge of the basic sciences and of the fundamentals of medicine so important in evaluating the patient's reaction to treatment. It is inconsistent that surgeons who have striven to maintain high standards in their own work are willing to delegate to a lay person the responsibilities involved in the administration of anesthetic drugs. One reason why surgeons have not recognized the importance and responsible position of the anesthesiologist is that there have been too few such specialists available. This situation is rapidly being

overcome. It is the responsibility of surgeons and hospital administrators to see that patients who are to take an anesthetic are given the best service that is available.

13. **Stuart C. Cullen,** Iowa City, Iowa: **Curare—Its Rational Use as an Adjunct to Anesthesia.**—(See p. 200.)

*Discussion:* **J. Dewey Bisgard,** Omaha, Neb., inquired of Cullen regarding the use of curare in the reduction of fractures. In his own experience it had been found very helpful. **Cullen** stated that the chief requisite of an anesthetic for fracture reduction is analgesia and that most agents producing analgesia give sufficient relaxation for this purpose. However, if an anesthetic is used which does not afford relaxation, curare is of definite value.

14. **Rudolph Janda,** Chicago, Ill.: **Observations on the Use of the Gelatin Sponge.**—In discussing the development of absorbable hemostatic substances, attention was directed to the sponge or foam prepared from ordinary commercial gelatin. Further experimental studies were presented on the hemostatic action of gelatin sponge. In a series of thirty dogs, wounds of various sizes were made in the liver, kidneys, and spleen. The gelatin sponge moistened in saline solution was applied or packed into the bleeding wound. Within three minutes hemostasis was usually obtained. When the gelatin sponge was soaked in thrombin, somewhat more rapid hemostasis was obtained but the difference was not outstanding. In an additional series of ten dogs, a substantial portion of the lobe of the liver was resected. In spite of the fact that large vessels were cut across, no sutures were used but the gelatin sponge was applied to the stump of the liver lobe and gentle pressure applied. Complete hemostasis was usually obtained within five to ten minutes. All animals survived the operation without secondary hemorrhage. The sponge became adherent to the raw surface of the liver so that within one-half hour it was difficult to lift the sponge away without tearing it. In dogs sacrificed at periods from two to thirty days, it was found that during the first ten days the sponge was adherent to the raw liver surface and in some instances it was transformed into a tough gelatinous mass. After two weeks the wound in the liver was usually healed. The gelatin sponge was used in a series of over sixty patients during operations such as cholecystectomy, splenectomy, thyroidectomy, and hemorrhoidectomy. In clinical surgery it was suggested that thrombin be added to the gelatin sponge and it was stressed that the method should serve as a supplement to the ligature or where ligatures are not appropriate.

*Discussion:* **Hilger P. Jenkins,** Chicago, Ill., suggested that it might be unwise to use the gelatin sponge in wounds in which a large number of silk or cotton sutures were employed. His reasons were that the gelatin sponge will produce some liquefaction and some increased serum reaction and in wounds such as thyroidectomy where many silk or cotton ligatures are present this may be detrimental. However, if it is used, one should endeavor to use the least amount of gelatin sponge compatible with securing the desired result.

15. **John T. Reynolds,** Chicago, Ill.: **Syphilitic Aneurysm of the Innominate Artery.**

16. **William M. Tuttle** and **James M. Winfield,** Detroit, Mich.: **Aneurysm of the Subclavian and Axillary Arteries.**

17. **H. Gurth Pretty,** Montreal, Canada: **The Diagnosis, Treatment and Pitfalls in Embolus of Peripheral Arteries.**—The following basic considerations of embolic occlusion were mentioned: (1) Pain does not occur simultaneously with arterial occlusions but develops some minutes later, usually following a period of paresthesia associated with a sense of coldness in the affected area. (2) The artery immediately peripheral to the occlusion is always in spasm by the time observation of the vessel is possible. (3) Spasm along with occlusion of major arterial trunks results in marked ischemia at the periphery. (4) The blood supply to the occluded areas comes by collateral routes or by oozing around the embolus. A thrombus often extends into the periphery from the original embolus (tail thrombus). It is occasionally necessary to differentiate between arterial embolus and spontaneous arterial thrombosis. Treatment should consist of relaxation of the spasticity of the arterial wall distal to the

embolus, the prevention of the formation of a tail thrombus, and, finally, mechanical removal of the embolus from the artery. Relaxation of vascular spasm is accomplished by means of a thermopack and paralysis of the sympathetic chain along with the use of heparin. Papaverine may also be used. The indications for embolectomy are (1) the limb that does not respond to the conservative treatment outlined, (2) a massive embolic occlusion at the bifurcation of the aorta or bilateral occlusions at the bifurcation of the common iliac vessels, (3) embolic occlusion of a duration not longer than six hours. The contraindications to the procedure are (1) patients too ill to posture, (2) embolus in such vessels as the anterior or posterior tibial or radial since arterial suture would occlude the lumen, (3) lapse of ten hours after the accident. The technique of embolectomy was described. The postoperative care recommended was paravertebral block if not previously done and continuous heparin for ten days, intermittent venous occlusion by Bier's passive congestion and keeping the legs flat on the bed or slightly dependent in order to avoid too rapid venous return. When embolectomy is done it should be done within six to ten hours at the latest. When embolectomy is contraindicated, lumbar ganglionectomy is advisable to limit the extent of gangrene. Ten days to two weeks should be allowed for the line of demarcation to develop. Amputation by refrigeration may be used to advantage.

18. **William T. Beck**, Chicago, Ill.: **Pulsating Hematoma and Secondary Hemorrhage.**—Observations in twenty-one pulsating hematomas in two General Army Hospitals were reported. When an artery is partially transected hemorrhage will continue and is limited only by the surrounding soft tissues. The flow of blood appears to be staunched soon after the injury by closure of the arterial rent by the surrounding muscles. For a short period of time this plug in the artery is apparently sufficient to stop hemorrhage. When muscular activity begins, the plug is pulled away and hemorrhage recurs. Often hemorrhage is observed through the original wound which is not yet healed. In other cases there is hemorrhage into the soft tissues and clotting occurs in the periphery of this hematoma, while in the center there remains a constant swirl of blood. Symptoms may be referable to the mass and pressure on surrounding structures, for example, nerves. Usually the first sign is a severe, almost exsanguinating hemorrhage occurring one to six weeks after injury. An expansile pulsation is often visible and a systolic bruit can be heard. In differential diagnosis, abscess and arteriovenous fistula must be excluded. Most arterial hematomas are surgical emergencies and all should be operated upon as soon as practicable. When acute hemorrhage occurs, direct pressure with a compression bandage must be used to control bleeding until intervention is possible. Large blood transfusions are of inestimable value. The operative procedure consists in isolation of the injured vessel, using the conventional incision rather than going through the most prominent part of the mass. In only one instance in this series was it possible to repair the injured vessel and this was done by excising the segment and performing an end-to-end anastomosis. In the remaining cases the vessel was ligated above and below the injured segment and the intervening portion excised or divided. Postoperative care consisted in cooling of the extremity, procaine sympathetic block, and the use of vasodilator drugs.

*Discussion:* **E. J. O'Brien**, Detroit, Mich., mentioned the importance of waiting until collateral circulation has developed when dealing with aneurysms of vessels such as the innominate and the carotid. He referred to a recent report by Helen Taussig in which seventy subclavian arteries were tied off early and no case of loss of function of the arm occurred. **Gordon Murray** reported briefly on over thirty embolectomies in which the circulation was restored satisfactorily in all, exclusive of aorta embolectomy. He emphasized the fact that none of the patients who have had major vessels tied off have perfectly normal extremities. The extremity is slightly shriveled and it does not retain its full power. Consequently, he favored reconstruction of the artery when feasible. He referred to the use of vein transplants as a solution to the problem in certain instances. **William Tuttle**, Detroit, Mich., agreed that vessels should be preserved when possible but that in dealing with large vessels high in the neck this is frequently out of the question.

19. **John L. Linquist,** Chicago, Ill.: **Multiple Arteriovenous Communications in the Upper Extremity.**—The rare condition of multiple arteriovenous communications in the extremities was reviewed with regard to etiology, diagnosis, and treatment. The most important clinical findings are the gross venous dilatation and tortuosity in association with more than one area of thrill and bruit. While a pulsating tumor may not be visible, pulsation is usually recognized by palpation. Increased temperature and trophic changes such as ulceration, deformity, or gangrene are noted in the extremity. Swelling is common and there may be increased length of the extremity. The small size of the fistulas in many cases of multiple arteriovenous anastomoses results in less prominent general and systemic manifestations than occur in cases of single large arteriovenous communications. The veins may be demonstrated to carry arterial blood and the connections may be visualized by arteriography. The difficulties encountered in surgical treatment were enumerated and a case was reported. The patient, a man 29 years of age, presented involvement of the right hand and forearm. Conservative treatment was inaugurated by the removal of a segment of radial artery and vein about four inches above the wrist, which was followed by improvement in the circulation of the hand. Six weeks later the disease had progressed and finally amputation of the hand at the wrist became necessary because of repeated profuse hemorrhage.

20. **Stuart Gordon,** Toronto, Canada: **The Role of Cancellous Bone in Plastic Surgery.**—(See p. 202.)

21. **Thomas G. Hays, Donald T. Jones, Thomas C. Ryan,** Philadelphia, Pa.: **Revisions and Re-Amputations.**—Experiences with 769 amputees with a total of 829 amputations were reviewed. Among these there were 563 guillotine type of amputations, 45 open-flap amputations, and 221 closed type of amputations. In retrospect they believe that many of the guillotine amputations could have been satisfactorily treated with an open-flap amputation saving many months of hospitalization. Revisions and reamputations of guillotine wounds were performed only through closed stumps when possible. When necessary, split-thickness perforated grafts were found useful in hastening the closure of a guillotine wound prior to further surgery. In reamputation, delayed primary closure of the wound was employed when a latent infection was suspected. The optimum points for amputation at the various levels were discussed. Disarticulations through the metacarpal-carpal joint, intercarpal joint, and wrist joint were performed in six patients and, contrary to the generally accepted views, had given satisfactory results.

*Discussion:* **Waltman Walters,** Rochester, Minn., described briefly the rehabilitation program for amputees at the Naval Hospital in Philadelphia. He referred to a prosthesis made by a method in which canvas is impregnated with a plastic material making a light and durable prosthesis and these were used instead of pylons.

22. **J. Harold Couch,** Toronto, Canada: **Deepening the Thenar Notch.**—Plastic procedures were discussed for the reconstruction of the thumb. A technique was described which had been found useful in deepening the thenar notch and this was illustrated by lantern slides.

23. **Irwin Schulz,** Milwaukee, Wis.: **Wringer Injury.**—A review was given of the experience at the Milwaukee Children's Hospital where, since 1935, sixty-four cases of wringer injury in children have been observed. In fifty of these cases intensively studied, only eight showed immediate fracture and in only three did pathologic fracture occur. In this same group there were only four nerve injuries, one involving the brachial plexus and three the musculospiral nerve. There were two deaths, one of purpura and one of septicemia. The fact was stressed that in injuries of this type progressive tissue damage occurs. This is due to uncontrolled edema, extravasation of fluid, and infection. He suggested that the viability of damaged tissue might be preserved by (1) removing contamination, (2) preventing infection, (3) applying pressure to support the damaged vessels and to prevent swelling, and (4) applying cold. Early skin grafting was emphasized as an important aid in shortening convalescence. Slides illustrating many examples of this type of injury were shown.

*Discussion:* **Kellogg Speed,** Chicago, Ill., added three more headings in the category of wringer injuries. They were (1) hot mangle or hot roller injuries in laundries or industry,

(2) elevator injuries where the limb is caught between the shaft of the car or in some mechanism, and (3) toboggan and slide injuries. The elevator injuries are the most severe on account of the magnitude of the pressure. They all occur from the squeezing or pressure which has been mentioned. The open wound, if any, may be small and the doctor is inclined to do a very small débridement. He believed that a very wide débridement should be done and the apparently normal or intact tissues should be split over the whole length of the limb which has been subjected to the pressure. The reason for this is that the subcutaneous fat is subjected to enormous pressure. Fat has a relatively poor blood supply as compared with skin or underlying muscle and, when thus compressed, its blood supply may be seriously interfered with, although it does not show at the time. The ischemia may continue until the fat undergoes necrosis and dissolves or it may become infected as it will if there is an infected wound. Another factor is the heat generated by the pressure at the moment of the accident. This cooks the fat and aids further in shutting off its blood supply. The skin may not show necrosis for two or three weeks but the necrosis or infection of the underlying fat spreads and finally the whole thing must be cut away and trimmed back and a proper field prepared for the application of a flap or skin graft. In the toboggan or slide injuries he suggested that the limb be opened widely, the fat examined and removed if necessary, and the skin closed. This should be followed by a compression dressing. **A. W. Farmer,** Toronto, Canada, emphasized the importance of prevention of wringer injuries. He believed that when the injured skin is likely to die it is best to remove the whole thing, make a free graft of the skin, and put it back again. If necessary, free partial thickness grafts may be used in addition. In his experience free grafts have taken well on the surface underneath the injured fat and skin.

24. **Donald M. Glover,** Cleveland, Ohio: **Preparation of the Open Wound for Closure; The Role of the Chlorine Antiseptic.**—The extensive use of early secondary closure of wounds in World War II was discussed. He listed the usual criteria for determining the suitability of wounds for closure as (1) vascularity of the granulating bed, (2) absence of necrotic tissue, (3) relative absence of exudate, (4) lack of edema, (5) healthy appearance of the marginal epidermis, and (6) minimal temperature elevation. In addition to this, a simple bacterial assay by wound washing was advocated as an additional criterion for estimating optimum conditions for secondary closure. Clinical and experimental evidence was presented which indicated that Dakin's solution more effectively controls the bacterial flora of the open wound than local treatment with saline dressings, azochloramid, sulfonamides, or penicillin. The effectiveness of Dakin's solution in the presence of exudate and slough was thought significant. Experimental observations were presented concerning the release of available chlorine by Dakin's solution and azochloramid.

25. **H. Hoyle Campbell,** Toronto, Canada: **A Method in the Management of Mulitple Facial Fractures.**—(See p. 204.)

26. **Carl C. Badgley,** Ann Arbor, Mich.: **Mechanics Explaining Non-union in Subtrochanteric Fractures and Intertrochanteric Fractures of the Femur** (abstract).—The statement was made that in general it was accepted that fractures in this location heal in a very high percentage of cases but certain types frequently do not unite. Emphasis was placed on the importance of a utility classification for fractures in the trochanteric area to select the proper therapy in the type of fractures which not infrequently fail to unite.

The first subdivision was classified as *junction fractures,* that is fractures which occur at the base of the neck at the junction to the shaft of the femur with or without involvement of the greater or lesser trochanters; second, the true intertrochanteric fracture, meaning by this a fracture which occurs directly through the intertrochanteric line involving the true shaft of the femur, and, third, subtrochanteric fractures, below the trochanters and above the gluteus maximus attachment.

It was stated that in the junctional fractures of the neck, nonunion occasionally occurred. The primary reason for this in Badgley's experience was the tendency on internal rotation

for the capsule, which was torn from its attachment to the intertrochanteric line, to fall in between the neck fragment and the shaft, producing an intervening material which could well produce nonunion. He felt that this type of fracture was best treated by operation with the principles of the Lawson-Thornton plate or the mechanically similar Blount blade or Moe plate or similar devices. In the third type of fracture, subtrochanteric, a new explanation for mechanics of the displacement of the fragments was presented. The vastus externus was found in seven consecutive cases to be stripped from its attachment to the linea aspera on the lower fragment remaining attached to the upper fragment. The gluteus maximus was still inserted on the linea aspera in the luteal ridge. The displacement backward and medially of the proximal end of the distal fragment was in part due to the pull of the gluteus maximus. The tearing of the vastus externus from the lower fragment, leaving it intact on the upper fragment, produced the displacement upward of the vastus externus so that it overlay the distal end of the upper fragment and was a definite factor in the production of nonunion. An operative approach was described, a posterolateral approach, which differed from Caldwell's posterior approach in that a lateral incision was employed and the fragments were exposed just posterior to the vastus externus border. The displaced upper end of the distal fragment was easily found without going through muscle substance by following posteriorly the attachment of the gluteus maximus to the linea aspera. Open reduction was advised in this type of fracture.

In recapitulation, the junction fracture and the subtrochanteric fracture, which cannot be readily reduced, were best treated by open reduction. The intertrochanteric fracture might well be treated by skeletal Russell traction or by conservative devices.

27. **John Martin,** Chicago, Ill.: **A Brief Statistical Survey of 333 Injuries of the Vertebral Column.**—The material presented was from an Army General Hospital in an overseas theater of war where 418 fractures of the vertebrae were observed in 333 patients. The greatest number of injuries occurred at the most movable parts of the vertebral column, that is, in the lower cervical region and at the junction of the thoracic and lumbar vertebrae. One hundred nine patients suffered severe neural injury and in this group 169 vertebrae were fractured. Even in this group a large proportion of which were battle casualties, the peak of the injuries was at the sixth cervical and first lumbar vertebrae. There were five deaths among the 119 patients with neural injury; one of pulmonary embolism, one of lung abscess and pneumonia, and three of respiratory failure. The following conclusions were drawn: (1) Injuries of the spinal cord are emergencies and in time of war such patients should be given a high priority as they pass down the line of evacuation; (2) the proper care of the bladder will do much to maintain the optimal condition of the patient and to prevent decubitus ulcers. Regardless of the type of therapy indicated, these patients present major problems in nursing care. If given proper treatment they will often respond in a far better manner than is generally appreciated.

28. **Bland W. Cannon** and **J. Grafton Love,** Rochester, Minn.: **Tardy Median Palsy; Median Neuritis; Median Thenar Neuritis Amenable to Surgery.**—(See p. 210.)

29. **Fraser B. Gurd,** Montreal, Canada: **Fundamentals of Technique in the Transverse Abdominal Incision.**—(See p. 217.)

30. **A. D. McLachlin,** Toronto, Canada: **Mortality in Abdominal Wounds in the Canadian Army.**

31. **O. W. Neimeier,** Hamilton, Ontario: **Modern Trends in the Treatment of Acute Cholecystitis.**—The recent trend toward early operation in acute cholecystitis has resulted in the performance of many partial and incomplete operations. Because of the poor general condition of the patient and the local congestion and edema of the parts, cholecystostomy only is frequently carried out. In a series of 105 operations for acute cholecystitis at the Hamilton General Hospital, cholecystostomy only was performed in 41, or 39 per cent. A review of the literature reveals similar findings in other reported series. For the same reasons there are comparatively few explorations of the common duct in these early opera-

tions. As the result of this incomplete surgery, many patients return for secondary operation. Secondary operations upon the biliary tract often present great technical difficulties and carry a high mortality. It was suggested that these undesirable results may be avoided if acute cholecystitis can be safely treated conservatively until the acute stage has subsided and the complete operation carried out later. In acute cholecystitis, obstruction at the neck of the gall bladder is usually the primary factor. Later infection supervenes and finally gangrene or perforation may occur. Neimeier believes that if chemotherapy is used in the early stage, infection can be controlled and the process in the majority of cases will subside under conservative treatment. He recommended the following program: (1) hospitalization with careful and frequent observation, (2) absolute rest for the gastrointestinal tract with gastroduodenal suction if distention and vomiting are marked, (3) adequate fluid and caloric intake, (4) chemotherapy, the sulfonamides being administered intravenously and with penicillin in addition in severe cases or when the response to sulfonamide therapy is not satisfactory. Operation is deferred until all of the symptoms have subsided. He reported his findings in a series of twenty-five consecutive cases, the patients being treated according to the proposed plan. The average time from the beginning of treatment to operation was thirteen days. There were no deaths. He believes that the next trend in the treatment of cholecystitis should be transfer of the emphasis from early operation to early and adequate conservative treatment.

*Discussion:* **Walter W. Carroll,** Chicago, Ill., commended Neimeier regarding his conservative stand toward the treatment of acute cholecystitis. He had seen a number of such patients treated conservatively during the past six years and all had done well with one exception and in that case operation was performed on the fifth or sixth day of the disease. He felt that a careful analysis of the statistics presented by many of those who favor an early operation does not support such a radical attitude.

32. **Edward H. Storer, Lester R. Dragstedt** and **James S. Clarke,** Chicago, Ill. **The Effect of Section of the Vagus Nerves to the Stomach on Gastric Secretion and Motility in Ulcer Patients** (abstract).—Since January, 1943, section of the vagus nerves to the stomach has been performed in fifty-seven patients with benign peptic ulcer. The technique employed to obtain complete bilateral vagus section and the clinical results in terms of ulcer healing and relief of symptoms have been described elsewhere. Large ulcers healed rapidly as determined by x-ray examination and symptoms attributable to the ulcer were unequivocally relieved in fifty-five of the fifty-seven. Studies of gastric secretion and motility were made before and after section of the vagus nerves.

The continuous night secretion of gastric juice, as collected by a Levine tube left in place in the stomach under continuous suction for twelve hours, was found to be consistently greater in volume and acidity in thirty patients with ulcer than that in forty-three patients without ulcer. Following transthoracic vagus section in seventeen of these ulcer patients, the volume and acidity of the night secretion were markedly reduced. Following transabdominal vagus section, supplemented by gastroenterostomy for pyloric stenosis, in thirteen patients with ulcer the average volume and acidity were also reduced.

In nineteen patients the gastric secretory response to hypodermically administered histamine was unaltered by vagus section. In fifteen patients the response to orally administered caffeine was unchanged following vagotomy. In thirty out of thirty-seven patients tested before vagotomy, a definite gastric secretory response, particularly a rise in acidity of the aspirated samples, occurred after hypoglycemia was induced by the subcutaneous injection of 20 to 30 units of crystalline insulin. Following vagus section this response was no longer present in twenty-eight of thirty-two patients tested. In response to a "sham meal," appetizing food chewed but not swallowed, a reflex increase in acidity of the gastric secretion preoperatively occurred in thirteen of seventeen patients. Following vagotomy only three of the seventeen still responded to this stimulus.

Gastric motility was studied in twenty-one patients with ulcer by means of a balloon inflated in the stomach and connected to a water manometer. Periodic "hunger contrac-

tions'' superposed on a basal tonus rhythm were observed in all, and many showed hypermotility. Records obtained up to two weeks following operation revealed a normal tonus rhythm, but the contraction waves were absent or diminished in amplitude. In three patients tracings obtained from two and one-half to eleven months following operation showed return of normal hunger contractions. Gastric sensation on distention of the balloon in the stomach was not grossly altered by vagotomy. Ten of twenty-three patients with ulcer experienced mild to moderate diarrhea for one to six weeks following vagotomy.

*Discussion:* **Dragstedt** said that all of the data so far obtained are in harmony with the concept that peptic ulcer is a psychosomatic disease. There is evidence that the vagus nerves in patients with ulcer are hyperactive or that there is a hypersecretory tonus. Clinical results following vagotomy to date have been excellent. He felt that the peptic ulcer problem is not solved by this work and suggested that psychiatrists use these same objective measurements which were described as an indication of the effectiveness of their therapy. **Waltmen Walters**, Rochester, Minn., complimented the work of Clarke and Dragstedt. He recalled the rapid subsidence of pain in patients with ulcer when hospitalized and put at complete rest. He believed that the patients who had gastroenterostomies in addition to vagotomy should be eliminated from the study of results since he still feels that gastroenterostomy is a good operation for chronic duodenal ulcer. He believed that in the evaluation of the results of vagotomy, only those cases in which no other procedures were carried out should be considered. He called attention to the fact that with the lapse of time and the larger number of patients treated by gastric resection for duodenal ulcer, a recurrence rate of at least 2 per cent will be encountered. He mentioned the importance of tissue susceptibility in patients who develop peptic ulcer. He intended to give vagotomy a clinical trial in cases of recurring ulcer after resections after gastroenterostomy, and in certain cases of duodenal ulcer intractable to medical treatment but not thought proper candidates for gastroenterostomy. **Dragstedt** reported ten cases in which vagotomy had been employed for large gastrojejunal ulcers, two of them in patients with gastroenterostomy and ten in patients following gastrectomy. In nine of these the jejunal ulcer healed and in one patient additional treatment was required because of obstruction. He, therefore, reasoned that jejunal ulcer might be prevented in gastroenterostomy when vagotomy is added. In the earlier cases of vagotomy no restrictions were placed upon eating, smoking, or drinking. However, he believed that patients should avoid whisky since the vagotomized stomach still responds to histamine and it seems to be true that alcohol stimulates gastric secretions through the release of histamine. He referred to experimental work in which isolated stomachs were made in dogs. Those animals in which the vagus nerves are left intact frequently develop ulcers whereas those in which the nerves are sectioned do not. **Edwin M. Miller,** Chicago, Ill., called attention to the fact that in vagotomy it is important to cut all of the fibers of the vagus in order to get the best results. In dissections of the vagus nerves in cadavers, he found a great variation in the distribution of the branches of the nerve. Lantern slides were shown illustrating some of the variations in anatomy which he had observed.

33. **John B. Condon** and **Harry A. Oberhelman**, Oak Park, Ill.: **Congenital Hypertrophic Pyloric Stenosis, Surgical Results.**—During the ten-year period from 1936 to 1945, inclusive, there were 15,976 patients admitted to the Cook County Children's Hospital. Sixty-seven of these patients were operated upon for congenital hypertrophic pyloric stenosis or suspected pyloric stenosis and the Rammstedt operation was performed. In this series of sixty-seven infants there were sixty males and seven females. First-born children were most frequently affected. The lesion was seen most often in healthy and well-developed infants as shown by the average birth weight of 7 pounds, 6½ ounces. Twenty-three of the patients were in a good state of hydration and forty-four were dehydrated. The three deaths in the series occurred in the latter group. The clinical findings were reviewed. In all cases the usual Fredet-Rammstedt operation was performed, local anesthesia being the anesthetic of choice. Two infants in the series required a second operation. In one of these the Fredet-Rammstedt operation was repeated successfully and in the other a posterior gastroenterostomy was performed with fatal outcome. In three instances, the duodenal mucosa was accidentally

opened but without ill effect. The total mortality was 4.4 per cent. It is believed that as soon as the diagnosis is made, the infant should be prepared for surgery. Such a plan allows an early restoration of the nutritional balance.

34. **Hillier L. Baker** and **D. W. Caldwell,** Chicago, Ill.: **Lesions of the Ampulla of Vater.**—The report was concerned with four different lesions of the ampulla of Vater, each of a different pathologic nature but with marked similarity of symptoms and findings such as persistent jaundice, pruritus, anorexia, weight loss, and stool color changes. The lesions discussed were: (1) cystic dilatation of the common bile duct, (2) benign papilloma of the ampulla, (3) adenocarcinoma of the ampulla, and (4) ulcer of the duodenum affecting the ampulla. It was concluded that in those cases of biliary tract obstruction in which the diagnosis remains doubtful the surgeon is thoroughly justified in exploring the ampulla of Vater transduodenally. They suggested transduodenal resection with reimplantation of the ducts for ampullar carcinomas 1 cm. or less in diameter providing they are quite circumscribed, show little gross evidence of infiltration, and do not extend into the pancreatic tissue. A description of each of the conditions listed was given along with an illustrative case report.

35. **John M. Waugh** and **O. Theron Clagett,** Rochester, Minn.: **Resection of the Duodenum and Head of the Pancreas for Carcinoma.**—(See p. 224.)

*Discussion:* **Lester Dragstedt,** Chicago, Ill., related some of his experiences with pancreatectomy in some 500 laboratory animals. When the pancreas of the dog is removed only about 10 per cent of the animals will require anything in addition to insulin to maintain them in good condition. Ninety per cent will become profoundly cachectic, develop hyperlipemia and fatty infiltration of the liver, and will die. They can be kept alive by the administration of lipocaic. When a part of the pancreas is removed and the pancreatic remnant is left behind with its ducts ligated, a similar situation obtains. When the ducts of the pancreatic remnant are not occluded, none of the animals develop symptoms of lipocaic deficiency and hence it would seem that implantation of the pancreatic remnant into the intestinal tract in operations in man is desirable. **Warren Cole,** Chicago, Ill., was in accord with the views expressed by the other speakers that the pancreatic duct should be implanted into the intestine at the time of pancreatoduodenectomy. Using illustrative lantern slides, he described the method of reconstruction which he had found most satisfactory.

36. **Herman E. Pearse,** Rochester, N. Y.: **Should We Standardize the Reconstruction After Pancreaticoduodenectomy?** (abstract).—During the last decade following the pioneer work of Whipple and Brunschwig, the operation for resection of the head of the pancreas and duodenum has emerged from "well-nigh insuperable" mechanical difficulties to become an accepted surgical procedure. In this interval practically every surgeon who has done the operation has modified the technique so that a review of the methods used makes one dizzy to follow the loops and turns used to reconstitute the patient's anatomy. Twenty-nine different ways of doing the operation have been described, yet there are only a few fundamental principles involved. It is felt that the emphasis should be shifted from the technique of the reconstruction to a study of the problems involved in restoring pancreatic function, to remove more adequately the regional lymph glands, and finally to the collection and analysis of a sufficient number of cases to evaluate the effectiveness of the operation in curing cancer.

The principles underlying the restoration of the continuity of the digestive tract are considered to be: (1) the use of a retrocolic, end-to-side gastrojejunostomy, (2) the implantation of the common bile duct into the intestine, (3) the reconnection of the pancreas to the intestine, and (4) the diversion of the gastrointestinal contents away from the liver and pancreas by antiperistalsis.

The chronology of development of these principles was discussed.

*Discussion:* **Alexander Brunschwig,** Chicago, Ill. (abstract).—The important questions in regard to pancreatoduodenectomy are whether or not the pancreatic juice must be returned to the gastrointestinal tract and, if so, how this is to be done. Neither of these questions can be answered at this time. Sufficient experience has now accumulated to indicate that pa-

tients may do quite well without external pancreatic secretion. If the stools are bulky, foul, and possibly too numerous, pancreatin may be given by mouth. The fact that pancreatic juice is normally secreted into the jejunum is, of course, the most important reason why its return to the bowel is desirable after pancreatoduodenectomy. However, in a monkey in which the head of the pancreas was excised and the pancreatic stump ligated and which survived four years and died of unknown causes, necropsy revealed no abnormalities in the bowel, liver, or other organs attributable to lack of pancreatic secretions or to other metabolic disturbances. There was not a fatty liver. The body of the pancreas was represented by a small cyst in the walls of which were numerous islets. No acinar tissue was present. Prior to death the animal was not diabetic. More time must elapse to permit of the observance of patients for prolonged periods before it is possible to know with certainty that a normal or near normal existence for indefinite periods is possible without pancreatic juice.

Various techniques have been described for reimplantation of the pancreatic duct system into the bowel. Brunschwig strongly urged that wherever possible surgeons obtain necropsies upon patients succumbing at any time after such operations and report these findings with the shortest possible delay since it is of paramount importance to know whether or not such anastomoses remain functional or become occluded by cicatrization. There is evidence that the latter occurs. **Pearse** told him of a patient in whom the transected pancreatic duct was implanted into jejunum and three months later developed steatorrhea; a good guess would seem to be that the anastomosis became occluded. Brunschwig's longest survivor following resection of the head of the pancreas and duodenum for carcinoma has now lived three years and, although there are two to three bulky stools a day, there has been no inconvenience and the patient is not receiving desiccated pancreas by mouth. Most of the fat ingested is absorbed.

Implantation of the pancreatic stump into jejunum may be carried out not so much to afford return of pancreatic secretion, but as a means of burial of the stump to avoid postoperative pancreatic fistula. Brunschwig has performed such implantations for this purpose with success in some instances. At present he continues to perform the operation first described in 1937 for the radical excision of the entire duodenum and head of the pancreas except that the procedure is now done in one stage and a choledochojejunostomy is done instead of cholecystojejunostomy. Where the common bile duct is not dilated and the gall bladder is present, he performs both choledocho- and cholecystojejunostomy on the same loop of jejunum. In most instances, at present, he expects and accepts postoperative pancreatic fistulas after ligation of the pancreatic stump. In his experience they have not resulted in undue inconvenience nor have they contributed to debility. Burial of the transected pancreatic stump into bowel wall is carried out in an attempt to avoid pancreatic fistulas if conditions are propitious and the resections have not entailed too much time. If *functioning* pancreatobowel anastomoses will prove to be feasible, the general adoption of such a step will be indicated routinely in pancreatoduodenectomy.

37. **Matthew Peelen,** Kalamazoo, Mich.: **Myo-epithelial Hamartoma of the Stomach.**

38. **E. Lee Strohl** and **Guy V. Pontius,** Chicago, Ill.: **Congenital Atresia of the Ileum.** In reviewing the literature it was found that the number of successful resections of the small intestine for atresia in infants is small. When massive resections are necessary for a long atretic area or for multiple areas of atresia, the prognosis depends somewhat upon the length of intestine which is left. A normal full-term infant possesses approximately 250 cm. of small intestine. Since atretic defects occur during the third or fourth month of fetal life, the defect found at operation represents the amount of bowel at this stage of embryonic development and therefore represents a far greater amount than may be realized when examining the atretic area at the time of surgery. Hence, when giving a prognosis it is believed to be necessary to determine the amount of small intestine preserved rather than to deduct the amount of small intestine resected. Two cases of extensive resections in newborn infants were reported. In one, celiotomy was performed, seventy-one hours after birth. The atretic segment began 30 cm. distal to the ligament of Treitz and after being resected measured 118 cm. In addition, there were two defects in the mesentery and through one of them the

terminal ileum, cecum, and ascending colon had herniated. The hernia was reduced and the normal bowel ends united by a side-to-side anastomosis. The child survived for 112 days and died of bronchopneumonia and inanition. In the second case the operation was performed when the infant was at the age of 42 hours. A cord atresia 3 cm. from the ileocecal junction was encountered with a defect in the mesentery through which the terminal ileum had herniated. There were several points of perforation or threatened perforation. The herniation was corrected and a segment of bowel measuring 53 cm. was resected, restoration being accomplished by side-to-side ileocecostomy. The infant did well and was improving until an upper respiratory tract infection devloped which proved fatal on the one hundred fourteenth day of life. It was suggested that in cases of this sort perforation of the bowel may occur at birth or possibly in utero and also that the gastrointestinal tract probably has a considerable compensatory ability. Therefore, if the infant can be kept alive long enough for this adjustment to take place, more of these infants can be saved.

*Discussion:* **Edwin Miller,** Chicago, Ill., related his experience of the past twenty years during which time he had had occasion to operate upon twenty-three congenital atresias of the small bowel, eleven of which were in the duodenum, with seven successful results and twelve in the ileum with two successful results. He showed lantern slides illustrating many of these operations and emphasized the importance of early recognition in order that surgical treatment may be carried out early enough to permit an anastomosis before the stage of peritonitis supervenes.

39. **J. G. Probstein,** St. Louis, Mo.: **Value of the Exclusion Operation in the Treatment of Intestinal Fistulas.**—(See p. 233.)

40. **Robert M. Wansbrough,** Toronto, Canada: **Complications of Meckel's Diverticulum.**—Surgical operation for a complication of a Meckel's diverticulum was required in 118 patients at the Hospital for Sick Children in Toronto during the past twelve years. These were classified as follows: (1) those having obstructive symptoms, 70, (2) acute diverticulitis, 14, (3) diverticulum acting as the head of an intussusception, 18, (4) intestinal obstruction not due to intussusception, 7, (5) hemorrhage, 9. The following points were brought out: (1) the importance of searching for a Meckel's diverticulum at the time of laparotomy when a relatively normal appendix is found and when a preoperative diagnosis of appendicitis has been made, (2) that all Meckel's diverticula with narrow necks should be removed when discovered, (3) that all Meckel's diverticula with thickening in the wall or with deformed walls should be removed, (4) a side-to-side anastomosis in children had proved to be the safest in the hands of Wansbrough, and (5) that hemorrhage from the bowel of an infant under 1 year of age is most likely to be due to bleeding from an ulcer in a Meckel's diverticulum.

*Discussion:* **Eugene Osius,** Detroit, Mich., referred to the literature concerning acute diverticulitis in children. The reported mortality in good surgical clinics throughout the country ranges from 20 to 60 per cent.

41. **Joseph E. Hamilton** and **Lachlan M. Cattanach,** Cleveland, Ohio: **Reconstruction of War Wounds of Colon and Rectum.**—(See p. 237.)

*Discussion:* **Arnold Griswold,** Louisville, Ky., commented upon the unanimity of opinion which now prevails regarding the technique of colostomy closure. He pointed out the defects in the method of extraperitoneal closure and mentioned the advantages of a meticulous dissection of the bowel ends after entering the peritoneal cavity and the importance of an accurate end-to-end anastomosis. **Eugene Osius,** Detroit, Mich., agreed that the intraperitoneal method of colostomy closure is especially important when dealing with war wounds. He reported his experiences with this problem at the U. S. Naval Hospital, Great Lakes, Ill.

42. **Laurence Sidney Fallis,** Detroit, Mich.: **Transverse Colostomy.**—(See p. 249.)

43. **David M. Movitz** and **George M. Curtis,** Columbus, Ohio: **Surgical Significance of the Accessory Spleen.**—It was stated that the effectiveness of splenectomy in the treatment of congenital hemolytic icterus or primary thrombocytopenic purpura is dependent on

whether accessory spleens, if present, are found and removed. The study was based on data obtained from 174 consecutive splenectomies and 4 explorations of the spleen at the Ohio State University Hospital. Fifty-six of these 178 patients, or 31.4 per cent, presented a total of 131 accessory spleens. The number of accessory spleens per patient varied from one to ten. Single as well as multiple accessories occurred predominantly in the young. The significance of splenosis was discussed and means for its prevention at the time of splenectomy mentioned. The 131 accessory spleens occurring in the 56 patients were distributed as follows: (1) hilar region, 54.2 per cent; (2) splenic pedicle, 25.1 per cent; (3) greater omentum, 12.2 per cent; (4) retroperitoneal area surrounding the tail of the pancreas, 6.1 per cent; (5) splenocolic ligament, 1.5 per cent; (6) mesenteries 0.75 per cent. In no patient were accessories found in more than two locations. In all instances of double location, the hilus constituted one of the two. The embryologic background of the condition was discussed.

44. **John R. Cochran,** Chicago, Ill.: **Vagotomy for Chronic Duodenal Ulcer: A Right Transthoracic Approach.**—The case was reported of a 46-year-old man who developed an anastomotic ulcer following partial gastrectomy for an intractable duodenal ulcer. Postoperatively he developed a left-sided pneumonia and empyema. A left-sided thoracotomy for drainage was necessary and the major portion of the eighth rib was resected. The recurrent ulcer had failed to respond to medical treatment and vagotomy was regarded as the procedure of choice. Diagnostic pneumothorax on the left side demonstrated that the lung was adherent to the chest wall. Accordingly a right-sided approach for the vagotomy was elected and the eighth rib resected. Bilateral vagus interruption was carried out without difficulty and the postoperative insulin test indicated a satisfactory elimination of vagal stimuli. The technical details of the operation were discussed. In addition to affording a satisfactory exposure, a definite advantage in the right-sided approach is the fact that the heart is well out of the way and the hazards associated with manipulation of that strucure are obviated.

45. **Bernard Larsen,** Madison, Wis.: **The Treatment of Pilonidal Cysts and Sinuses by Excision and Primary Closure** (abstract).—The subject was presented as a moving picture which demonstrated the technique of elliptical block excision and primary closure with rows of subcutaneous fine cotton sutures. It was emphasized that the operation should not be done in the face of acute inflammation, undercutting should be avoided, the deepest row of sutures should be placed where the fat can be brought together without undue tension which is usually up on the walls and not in the bottom of the wound, and the skin should be meticulously closed. Sulfanilamide crystals placed on the closed wound (not in the wound itself) are hygroscopic enough to control the moisture of the area and bacteriostatic enough to protect the wound from bacterial invasion along the skin sutures. Scrupulous postoperative observation and care are essential.

*Discussion:* **Donald Glover,** Cleveland, Ohio, mentioned that in the overseas theater in which he had recently worked there were somewhere in the neighborhood of 1,000 pilonidal sinus operations out of somewhat over one million admissions in 175 hospitals. He reported on three groups of cases; in one primary suture was employed, in one the wound was allowed to granulate in after excision, and in one immediate skin grafting was employed. The later group was the most satisfactory from the standpoint of time, as men were allowed to return to duty earlier. However, the cosmetic results were not good and the final conclusions were that excision with primary closure was the method of choice. In the latter part of the war it was the policy of the army hospitals to operate upon fewer and fewer pilonidal sinuses. It was felt that many of the minor lesions were not too distressing or disabling if left untreated.

46. **John K. Ormond,** Detroit, Mich.: **Radical Perineal Prostatectomy for Carcinoma of Prostate.**—(See p. 257.)

47. **Reed M. Nesbit and Robert T. Plumb,** Ann Arbor, Mich.: **Prostatic Carcinoma.**—(See p. 263.)

48. **Reed M. Nesbit** and **Jack M. Lynn**, Ann Arbor, Mich.: **Malignant Testicular Neoplasms.**—(See p. 273.)

49. **Charles W. McLaughlin, Jr.**, Omaha, Neb.: **Novocain Infiltration in the Treatment of Acute Ankle Injuries Without Fracture.**—(See p. 280.)

50. **John A. Wolfer** and **Walter W. Carroll**, Chicago, Ill.: **Experimental Study of Wound Healing in Vitamin C Depleted Human Subjects.**—A carefully controlled study was made regarding the effects on wound healing of a prolonged vitamin C deficiency in nine otherwise normal healthy young males. Five normal healthy young males were available as controls. Each subject voluntarily submitted to a diet free of all vitamin C for a period of seven months. Surgical incisions were then made in the left thigh and carried down through the fascia. The wounds were closed with interrupted silk sutures. The following studies were subsequently made: (1) the tensile strength of the wounds by means of the tensiometer; (2) histologic studies of the tissues during the healing phase, and (3) the response to the ascorbic acid saturation test. The following conclusions were drawn: (1) Human subjects on prolonged ascorbic acid depletion exhibit a recognizable lack of collagen in the healing wounds; (2) normal human subjects on prolonged ascorbic acid depletion exhibit an approximate 50 per cent diminution in tensile strength in uncomplicated healing wounds; (3) such ascorbic acid depletion alone delays the development of normal tensile strength in an uncomplicated healing wound from three to five days up to the fourteenth postoperative day. This delay occurs in the most critical period of wound healing.

51. **William E. Abbott, John Winslow Hirshfeld, Harold H. Williams, Matthew A. Pilling,** and **Frieda L. Meyer**, Detroit, Mich. **Metabolic Alterations Following Thermal Burns.**—(See p. 284.)

52. **Robert R. Bates**, Joliet, Ill.: **Trench Foot.**—On one of the Army General Hospitals in the United States designated as a trench foot center, 4,892 soldiers with frostbite and trench foot injuries were admitted in the four months following February, 1945. Two hundred sixty-four presented surgical problems in that they had varying degrees of persistent gangrene. Every attempt was made to obtain the maximum improvement under conservative treatment. Exercises were useful in freeing adhesions about tendon sheaths and joint capsules. Routine bacteriologic studies were made of exudates taken at the line of demarcation. Surgery was advised only after all spontaneous improvement had ceased and in many instances no surgical therapy was necessary. It was found that grafted skin was unsatisfactory as a means of covering stumps of feet. Good plantar skin flaps used to cover end stumps gave good functional results. Removal of metatarsal heads was sometimes necessary to permit this type of plastic repair. The true guillotine type of amputation was abandoned and an open flap type of amputation used instead. A secondary closure was often possible a few days later. Skin traction was found useful in eliminating strain at a suture line. Occasionally flap or tube grafts from the opposite leg were used rather than resorting to amputation. A simple prosthesis for patients with fore-shortened feet consisting of a shoe insole with a felt block to fill in the space between the foot stump and shoe tip was described.

*Discussion:* **Grover Penberthy**, Detroit, Mich., reviewed the army experience in the care of trench foot where a policy of very conservative therapy was adopted early. He commented on the high morale of these patients, which was engendered by group physiotherapy and the encouragement given by the medical officers.

53. **Kenneth N. Campbell, Vivian L. Iob,** and **Robert L. Berry**, Ann Arbor, Mich.: **The Effect of Dextrose Upon the Rate of Loss of Sodium in the Postoperative Patient** (abstract).—In a recent study reported by Gamble and Butler, it was reported that dextrose administered to a fasting subject was capable of conserving loss of sodium and extracellular fluid. This deduction was somewhat opposed to the widely accepted observation that a deficit of extracellular fluid cannot be repaired by dextrose alone, that is, the lost electrolyte must be replaced.

The verification of this postulation was deemed sufficiently important to provoke a modification of a series of experiments which had been under investigation at the University Hospital for the past several years. These studies concerned themselves with the manner in which the human body handles intravenous infusions of saline solutions.

Cumulative balances of sodium, chloride, and water, and the rate of excretion of the various urinary constituents were determined in the thirty-hour postoperative period, beginning with the operation. Measurements of wound losses and calculations of insensible loss were also taken into account.

The studies showed conclusively that the addition of dextrose to salt solutions of varying tonicity or the infusion of dextrose solutions alone failed to conserve sodium in greater degree than if saline solutions alone were infused. Losses in both series were comparable.

The conclusion was made that the infusion of saline in dextrose did not lead to further retention of electrolyte in the postoperative patient. This is contrary to the hypothesis of Gamble and Butler.

54. **Lloyd Burk,** Ann Arbor, Mich.: **Recurrent Parathyroid Adenoma: A Case Report.**

55. **Robert C. Bassett,** Ann Arbor, Mich.: **The Medullary Angiomas** (abstract).—The clinical characteristics of these angiose anomalies of the spinal cord and pia arachnoid were presented with the point of view in mind that more or less consistently these lesions present a bizarre neurologic picture which may or may not have remissions and which tends to be progressive in nature, frequently associated with pain out of all proportion to the clinical objective findings.

Slides demonstrating the typically suggestive gross deformity of the anomalous vessels by means of contrast media were shown.

Gross and histologic pathologic features of the lesions were discussed. A method of surgical management as opposed to other therapy (x-ray) was presented.

*Discussion:* **J. Grafton Love,** Rochester, Minn., stated that his experience had not been quite so fortunate in dealing with these cases. He had encountered several of these hemangiomas of the spinal cord. He was rather loathe to attempt removal of some of these tumors since he felt that in so doing one may compromise the blood supply of the cord and actually increase the neurologic symptoms. Hence it is his practice frequently to leave them alone if a subarachnoid block has been demonstrated prior to operation. He felt that palliative decompression was often all that is possible and he agreed that x-ray or radium therapy are of no value and may possibly injure the normal vessels within the cord.

# Book Reviews

**Classic Descriptions of Disease.** By Ralph H. Major, M.D., Professor of Medicine, University of Kansas School of Medicine, Kansas City, Kan. Pp. 679, with 158 illustrations. Springfield, Ill., 1945, Charles C Thomas, Publisher. $6.50.

The third edition of this now well-known anthology will continue to assure the past popularity of the book with the medical profession. A few new selections have been added. An entirely new feature is the addition of a bibliography which will prove most helpful for students who desire to look up the original papers from which the author has made his selections.

As the author admits, there is a certain lack of proportion and unbalanced emphasis in certain sections of the book. For instance, the section on Diseases of Metabolism covers only 77 pages, while Diseases of the Circulatory System is given 161 pages. This, however, cannot be considered as a real defect in the preparation of the book, but rather an indication of the author's personal taste and interests. Subsequent editions can be expected to expand those sections now sparsely represented.

Short bibliographic sketches of many of the authors quoted are included with the selections of their works. These add considerable general as well as historical interest to the work. This book is good interesting reading for both the medical student and the practitioner. From the writings of 195 different men, 287 different selections have been included. The 158 illustrations are, for the most part, portraits of the authors quoted. All the selections are in English.

**Amputation Prosthesis.** By Atha Thomas, M.D., F.A.C.S., Associate Professor of Surgery (Orthopedics), University of Colorado School of Medicine, and Chester C. Haddan, President of the Association of Limb Manufacturers of America. Pp. 306, with 207 illustrations. Philadelphia, 1945, J. B. Lippincott Company. $8.

There has long been a crying need for a clear presentation of the problem of amputations from the viewpoint of the artificial limb maker. This book more than answers the purpose. With excellent illustrations, the authors outline the good and bad types and sites of amputations for all four extremities and present their reasons in terms of the problems, construction, and fitting of prostheses. There is ample space given to aftercare, training, and rehabilitation. The book is written in clear and readable style, and abundantly backed with references. It is an admirable example of collaboration between surgeon and limb maker, and belongs on the desk of anyone who does even occasional amputations.

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## BOOKS RECEIVED

The receipt of books is acknowledged in this section and this treatment must be regarded as sufficient acknowledgment of the courtesy of the senders. Selections will be made for more extensive review dictated by the interests of our readers and as space permits.

THE EXTREMITIES. By Daniel P. Quiring, Ph.D., Head of Anatomy Division; Beatrice A. Boyle, Artist; Erna L. Borousch, M.A., Fellow Anatomy; and Bernardine Lufkin, A.B., Cleveland Clinic Foundation. Cloth. Price $2.75. Pp. 117, with 106 illustrations. Philadelphia, 1945, Lea & Febiger.

PATHOLOGY IN SURGERY. By N. Chandler Foot, M.D., A.B., Professor of Surgical Pathology, Cornell University Medical School, New York, N. Y. Cloth. Price $10. Pp. 512, with 368 illustrations. Philadelphia, 1945, J. B. Lippincott Company.

MEN WITHOUT GUNS. By DeWitt MacKenzie, War Analyst of Associated Press, Foreword by Major General Norman T. Kirk, Surgeon General of U. S. Army. Cloth. Price $5. Pp. 47, with 118 illustrations. Philadelphia, 1945, The Blakiston Company.

EXTENSILE EXPOSURE APPLIED TO LIMB SURGERY. By Arnold K. Henry, M.B., M.Ch., Emeritus Professor of Clinical Surgery in the University of Egypt. Cloth. Price $7. Pp. 180, with 127 illustrations. Baltimore, 1945, Williams & Wilkins Company.

ADVANCES IN ENZYMOLOGY. Edited by F. F. Nord, Fordham University, New York, N. Y., and C. H. Werkman, Iowa State College, Ames, Iowa. Cloth. Pp. 408, with 12 illustrations. New York, 1943, Interscience Publishers, Inc.

ADVANCES IN INTERNAL MEDICINE. Edited by J. Murray Steele, M.D., Welfare Hospital, New York, N. Y. Cloth. Pp. 292, with 8 illustrations. New York, 1942, Interscience Publishers, Inc.

THE CHEMISTRY OF ANESTHESIA. By John Adriani, M.D., Director, Department of Anesthesia, Charity Hospital of Louisiana, New Orleans, La. Cloth. Price $7. Pp. 536, with 45 illustrations. Springfield, 1946, Charles C Thomas, Publisher.

SURGICAL TREATMENT OF THE MOTOR-SKELETAL SYSTEM, Part I and Part II. Edited by Frederic W. Bancroft, A.B., M.D., F.A.C.S., Associate Clinical Professor of Surgery, Columbia University, and Clay Ray Murray, M.D., F.A.C.S., Professor of Orthopedic Surgery, College of Physicians and Surgeons, Columbia University. Cloth. $20 a set. Pp. 1,251, with 1,063 illustrations. Philadelphia, 1945, J. B. Lippincott Company.

ROENTGENOLOGY OF THE GASTROINTESTINAL TRACT. By John T. Farrell, Jr., M.D., Clinical Professor of Radiology, Graduate School of Medicine, University of Pennsylvania. Cloth. Price $5.50. Pp. 271, with 190 illustrations. Springfield, 1946, Charles C Thomas, Publisher.

DR. W. C. RONTGEN. By Otto Glasser, Cleveland Clinic Foundation. Paper. Pp. 169. Springfield, 1945, Charles C Thomas, Publisher.

AN INTRODUCTION TO ESSENTIAL HYPERTENSION. By Richard F. Herndon, M.D., F.A.C.P. Cloth. Pp. 88, with 6 illustrations. Springfield, 1946, Charles C Thomas, Publisher.

HOSPITAL CARE OF THE SURGICAL PATIENT. By George Crile, Jr., M.D., Surgeon, Cleveland Clinic, and Franklin L. Shively, Jr., M.D., Assistant Surgeon, Cleveland Clinic. Foreword by Evarts A. Graham, M.D., Bixby Professor of Surgery, Washington University School of Medicine, St. Louis, Mo. Cloth. Price $3.50. Pp. 288, with no illustrations. Springfield, 1946, Charles C Thomas, Publisher.

ANATOMY OF THE HEAD AND NECK. By R. T. Hill, Ph.D., Associate Professor of Anatomy, Indiana University Schools of Medicine and Dentistry, Bloomington, Ind. Cloth. Pp. 125, with 30 illustrations. Philadelphia, 1946, Lea & Febiger.

AN INTRODUCTION TO CLINICAL SURGERY. By Charles F. M. Saint, C.B.E., M.D., F.R.C.S. (England), Professor of Surgery, University of Cape Town, South Africa. Cloth. Pp. 293. Capetown, 1945, The African Bookman, Publisher.

NURSING AND NURSING EDUCATION. By Agnes Gelinas, R.N., A.M., Professor of Nursing and Chairman of the Skidmore College, Department of Nursing, New York Post-Graduate Medical School and Hospital. Cloth. Price $1. Pp. 72. New York, 1946, Commonwealth Fund.

MEDICINE IN INDUSTRY. By Bernhard J. Stern, Ph.D., Lecturer in Sociology, Columbia University. Cloth. Price $1.50. Pp. 209. New York, 1946, Commonwealth Fund.

NURSING IN COMMERCE AND INDUSTRY. By Bethel J. McGrath, R.N. Cloth. Price $3. Pp. 356. New York, 1946, Commonwealth Fund.

HIPPOCRATIC WISDOM. By William F. Petersen, M.D. Cloth. Price $5. Pp. 263. Springfield, 1946, Charles C Thomas, Publisher.

THE TRAUMATIC DEFORMITIES AND DISABILITIES OF THE UPPER EXTREMITY. By Arthur Steindler, M.D., F.A.C.S., Professor and Head of Department of Orthopedic Surgery, State University of Iowa, in collaboration with John Louis Marxer, M.D., State University of Iowa. Cloth. Price $10. Pp. 515, with 1,048 illustrations. Springfield, 1946, Charles C Thomas, Publisher.

AMBULATORY PROCTOLOGY. By Alfred J. Cantor, M.D., Associate Proctologist, Kew Gardens General Hospital, Long Island, N. Y., with Foreword by Beaumont S. Cornell, M.D., Editor, *American Journal of Digestive Diseases*. Cloth. Price $8. Pp. 524, with 281 illustrations. New York, 1946, Paul B. Hoeber, Inc.

ESSENTIALS OF GENERAL ANESTHESIA. By R. R. Macintosh, M.A., M.D., Nuffield Professor of Anesthetics. Cloth. Pp. 341, with 239 illustrations. Springfield, 1945, Charles C Thomas, Publisher.

SURGICAL TREATMENT OF THE NERVOUS SYSTEM. By Frederick W. Bancroft, A.B., M.D., F.A.C.S., Associate Clinical Professor of Surgery, Columbia University. Cloth. Pp. 534, with 293 illustrations. Philadelphia, 1946, J. B. Lippincott Company.

DISEASES OF THE ADRENALS. By Louis J. Soffer, M.D., Adjunct Attending Physician, Mount Sinai Hospital, New York, N. Y. Cloth. Price $5.50. Pp. 304, with 44 illustrations. Philadelphia, 1946, Lea & Febiger.

PREOPERATIVE AND POSTOPERATIVE TREATMENT. By Lieutenant Colonel Robert L. Mason, Medical Corps, Army of the United States, Cushing General Hospital, Farmingham, Mass., and Harold A. Zintel, M.D., Harrison Department of Surgical Research, University of Pennsylvania School of Medicine. Cloth. Price $7. Pp. 584, with 157 illustrations. Philadelphia, 1946, W. B. Saunders Company.

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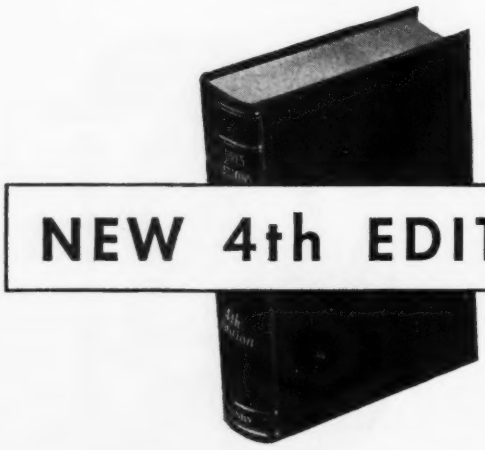


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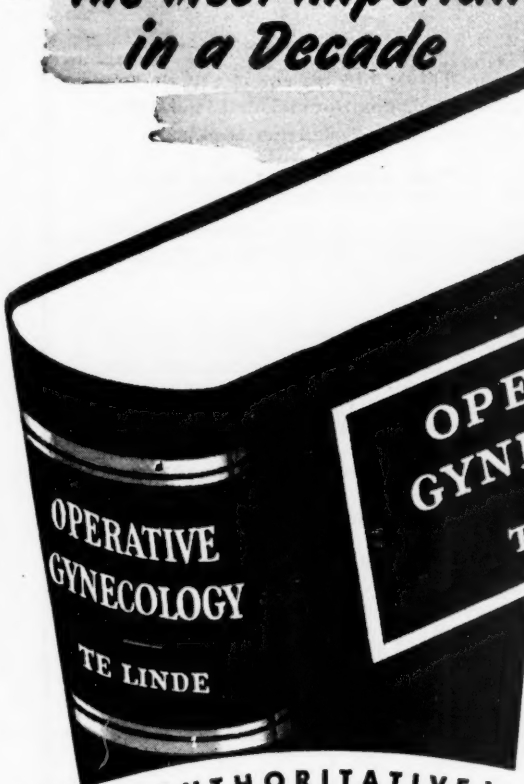


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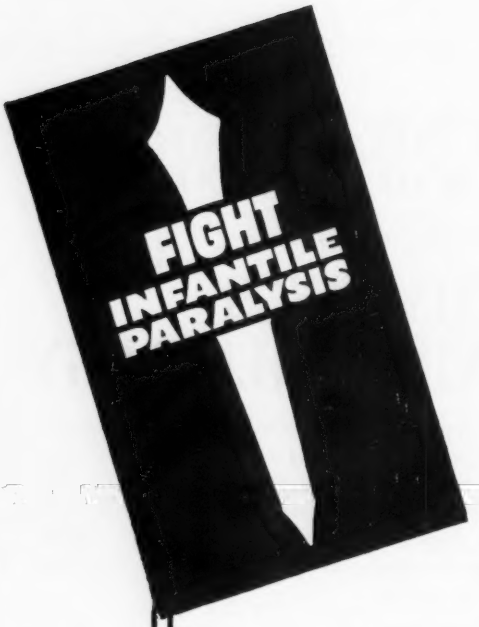


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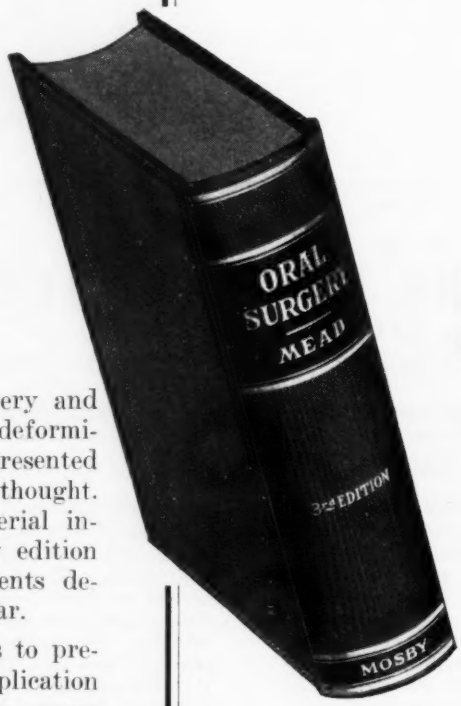


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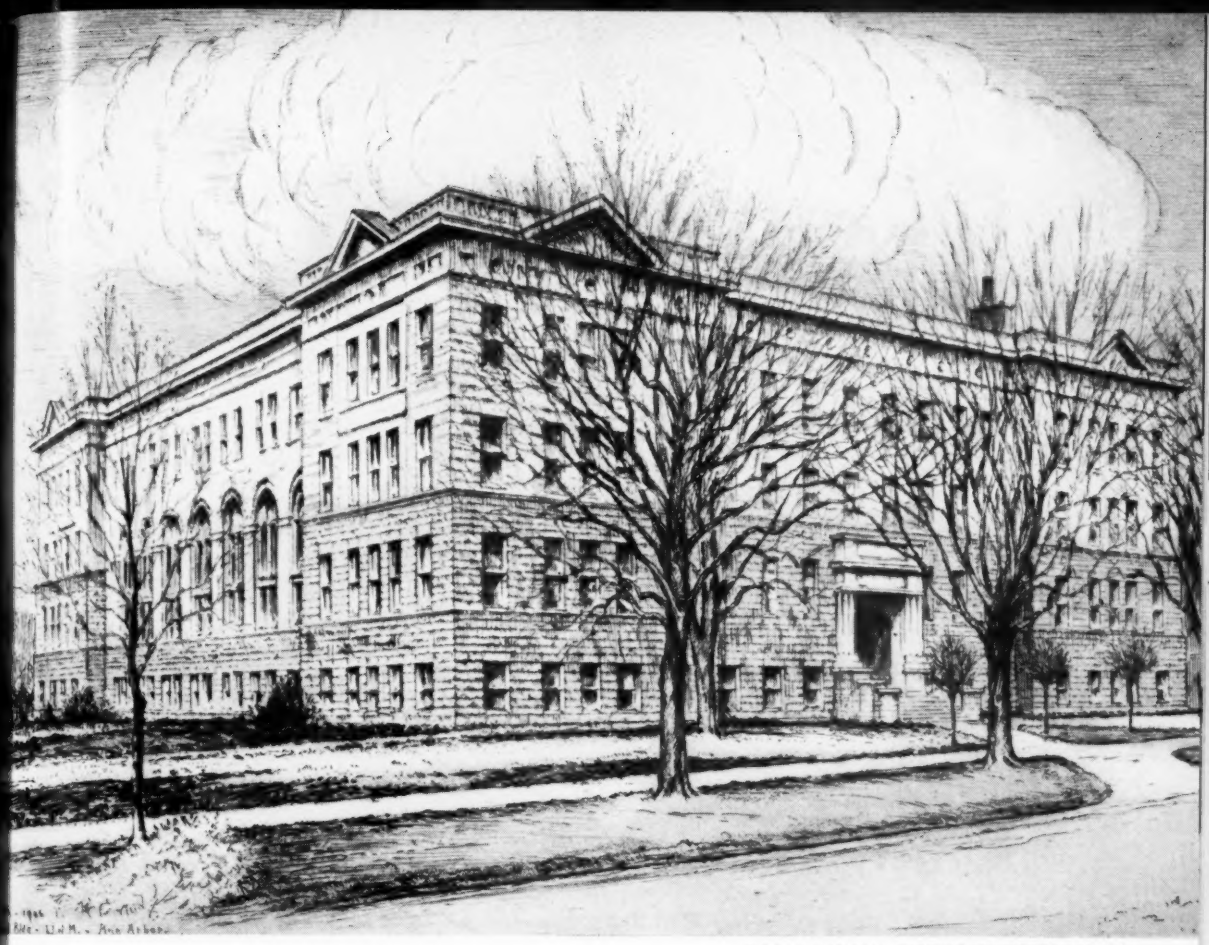

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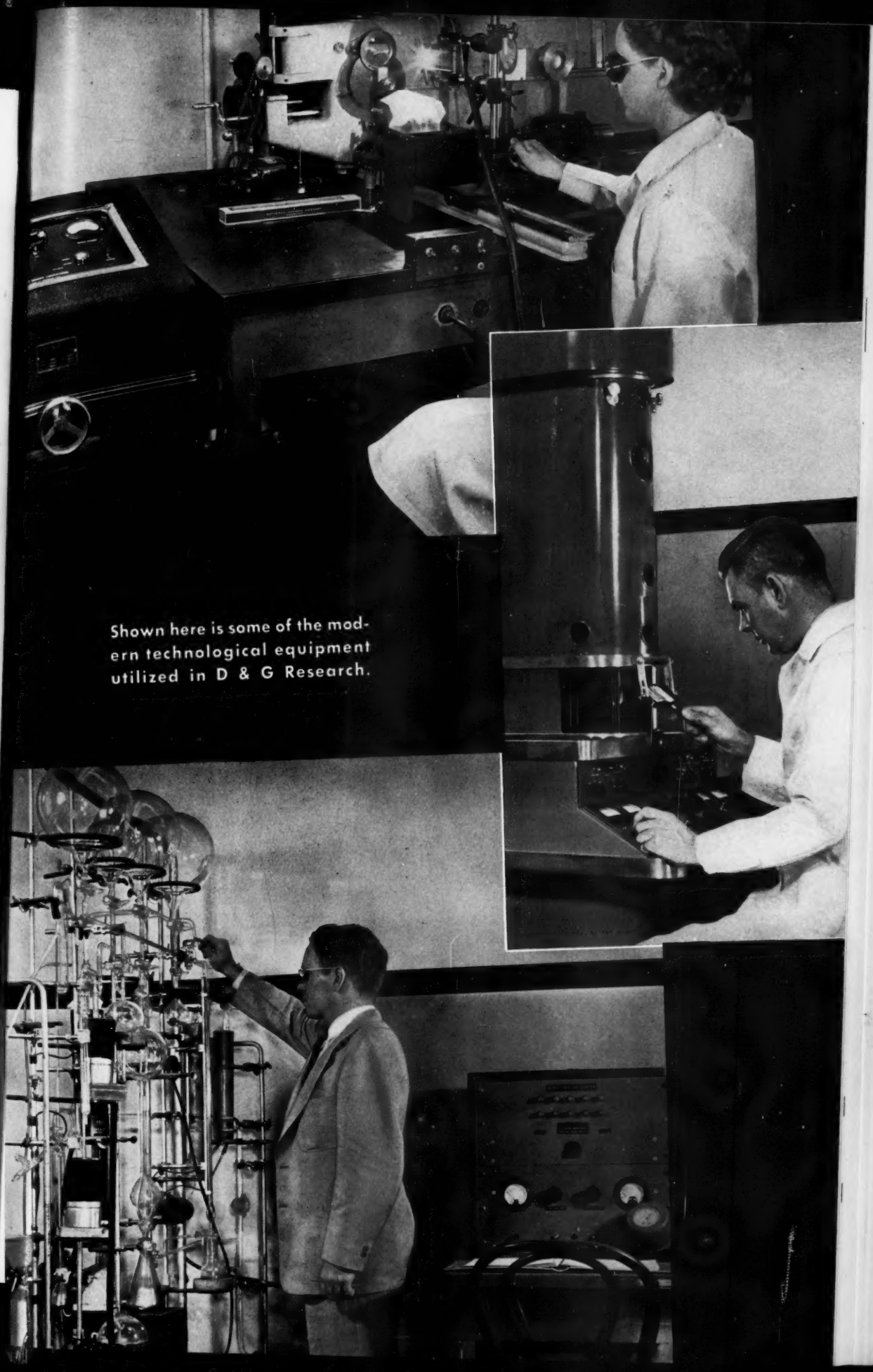

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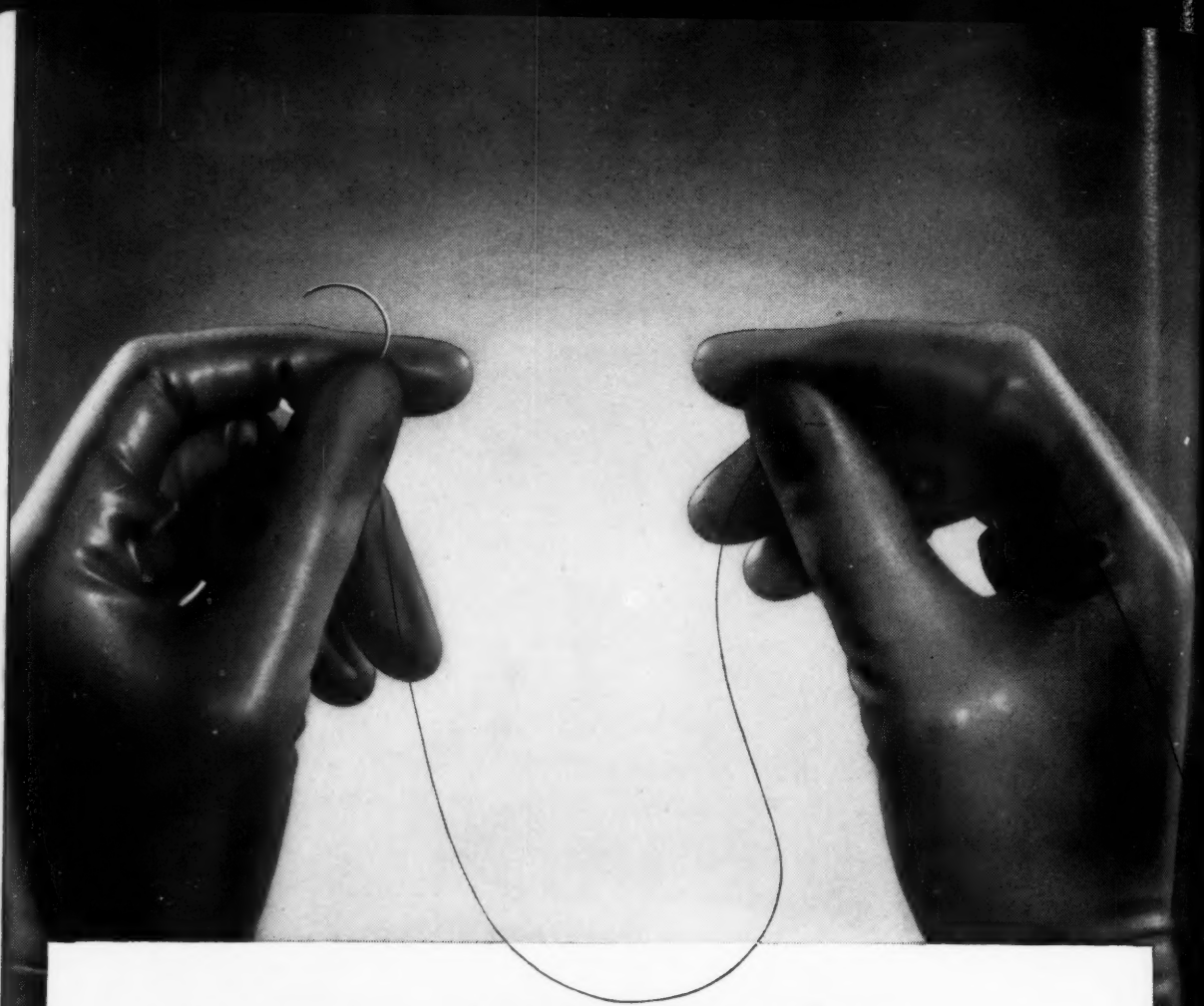

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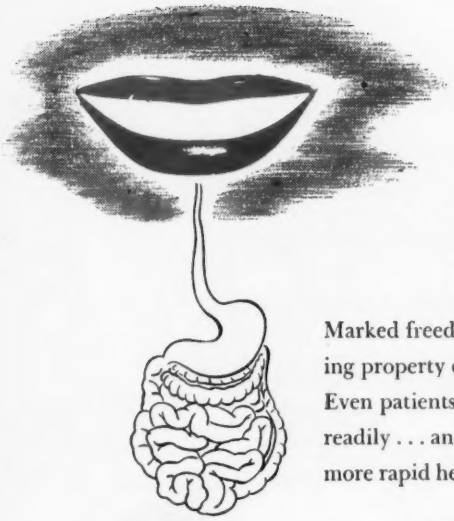

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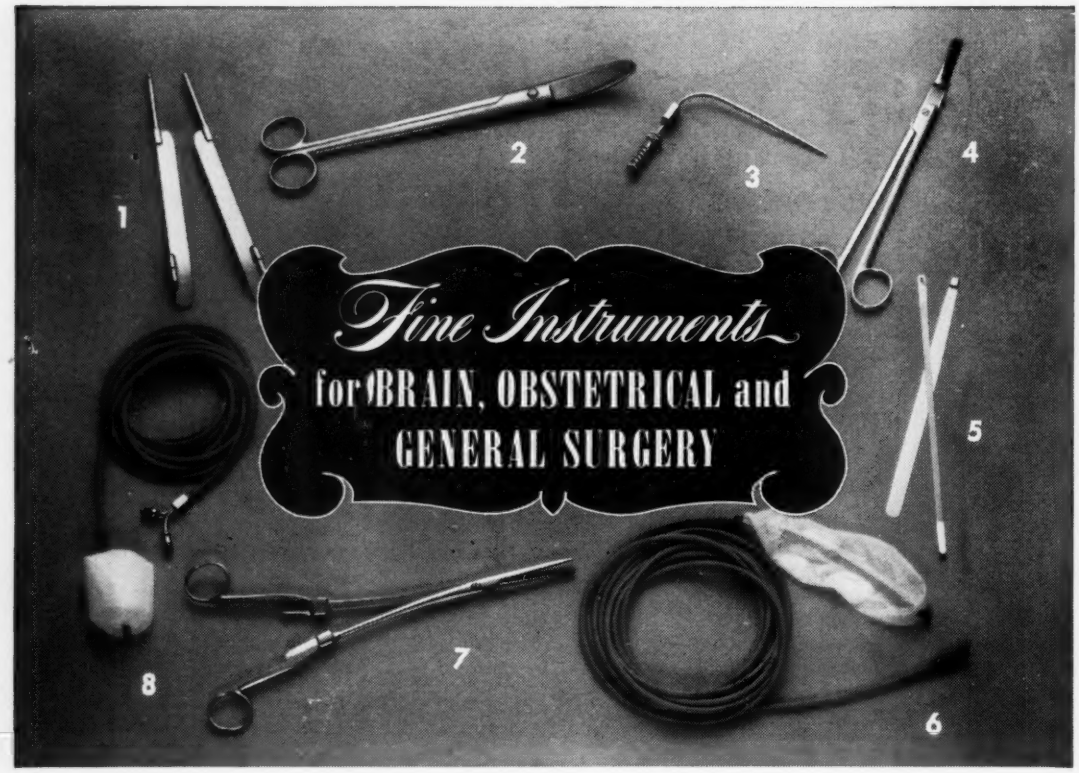


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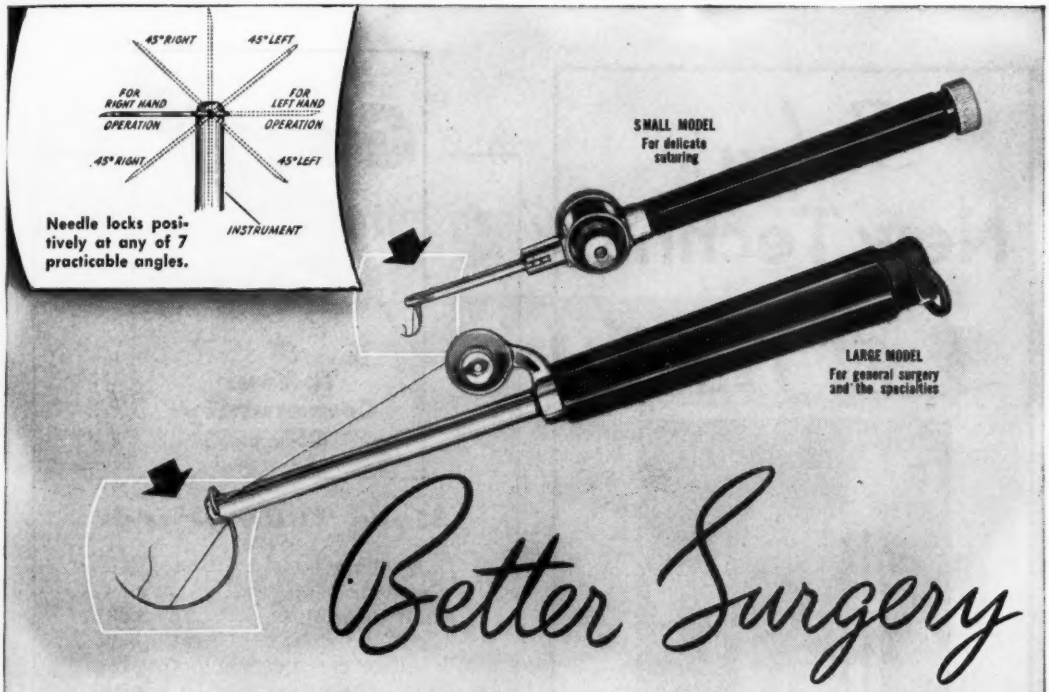


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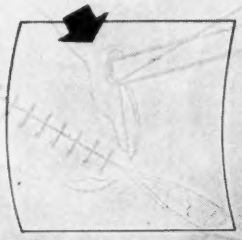

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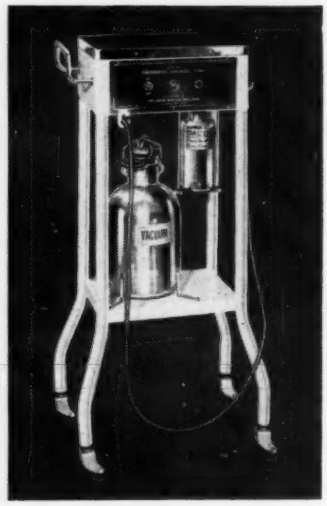

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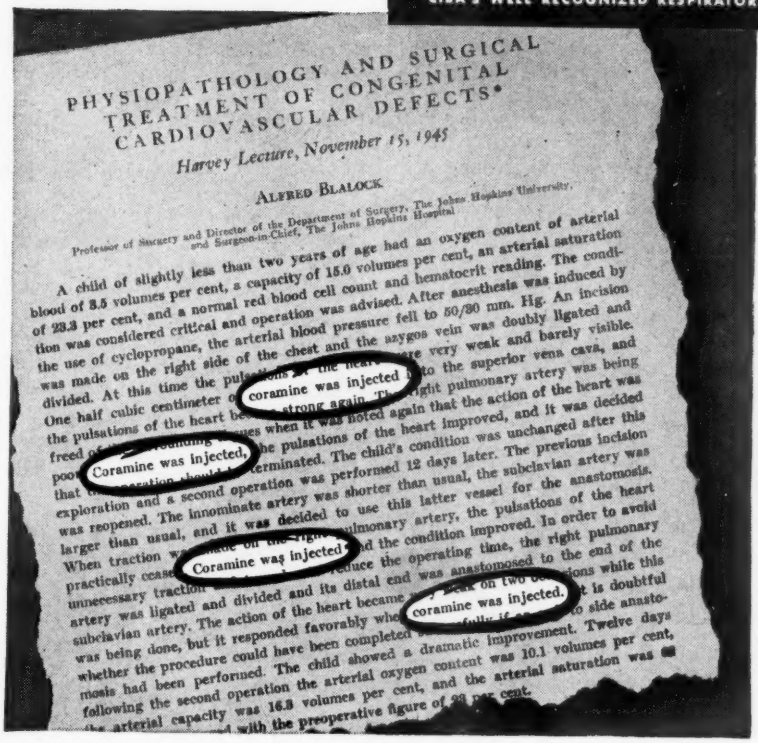

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ALFRED BLALOCK

Professor of Surgery and Director of the Department of Surgery, The Johns Hopkins University, and Surgeon-in-Chief, The Johns Hopkins Hospital

A child of slightly less than two years of age had an oxygen content of arterial blood of 8.5 volumes per cent, a capacity of 15.0 volumes per cent, an arterial saturation of 23.3 per cent, and a normal red blood cell count and hematocrit reading. The condition was considered critical and operation was advised. After anesthesia was induced by the use of cyclopropane, the arterial blood pressure fell to 50/30 mm. Hg. An incision was made on the right side of the chest and the azygos vein was doubly ligated and divided. At this time the pulsations [illegible] to the superior vena cava, and One half cubic centimeter [illegible] strong again. The [illegible] right pulmonary artery was being the pulsations of the heart [illegible] when it was noted again that the action of the heart was freed [illegible] the pulsations of the heart improved, and it was decided that [illegible] terminated. The child's condition was unchanged after this exploration and a second operation was performed 12 days later. The previous incision was reopened. The innominate artery was shorter than usual, the subclavian artery was larger than usual, and it was decided to use this latter vessel for the anastomosis. When traction was made on the right pulmonary artery, the pulsations of the heart practically ceased [illegible] and the condition improved. In order to avoid unnecessary traction [illegible] reduce the operating time, the right pulmonary artery was ligated and divided and its distal end was anastomosed to the end of the subclavian artery. The action of the heart became [illegible] on two occasions while this was being done, but it responded favorably when [illegible] it is doubtful whether the procedure could have been completed [illegible] to side anastomosis had been performed. The child showed a dramatic improvement. Twelve days following the second operation the arterial oxygen content was 10.1 volumes per cent, the arterial capacity was 16.5 volumes per cent, and the arterial saturation was [illegible] with the preoperative figure of [illegible] per cent.

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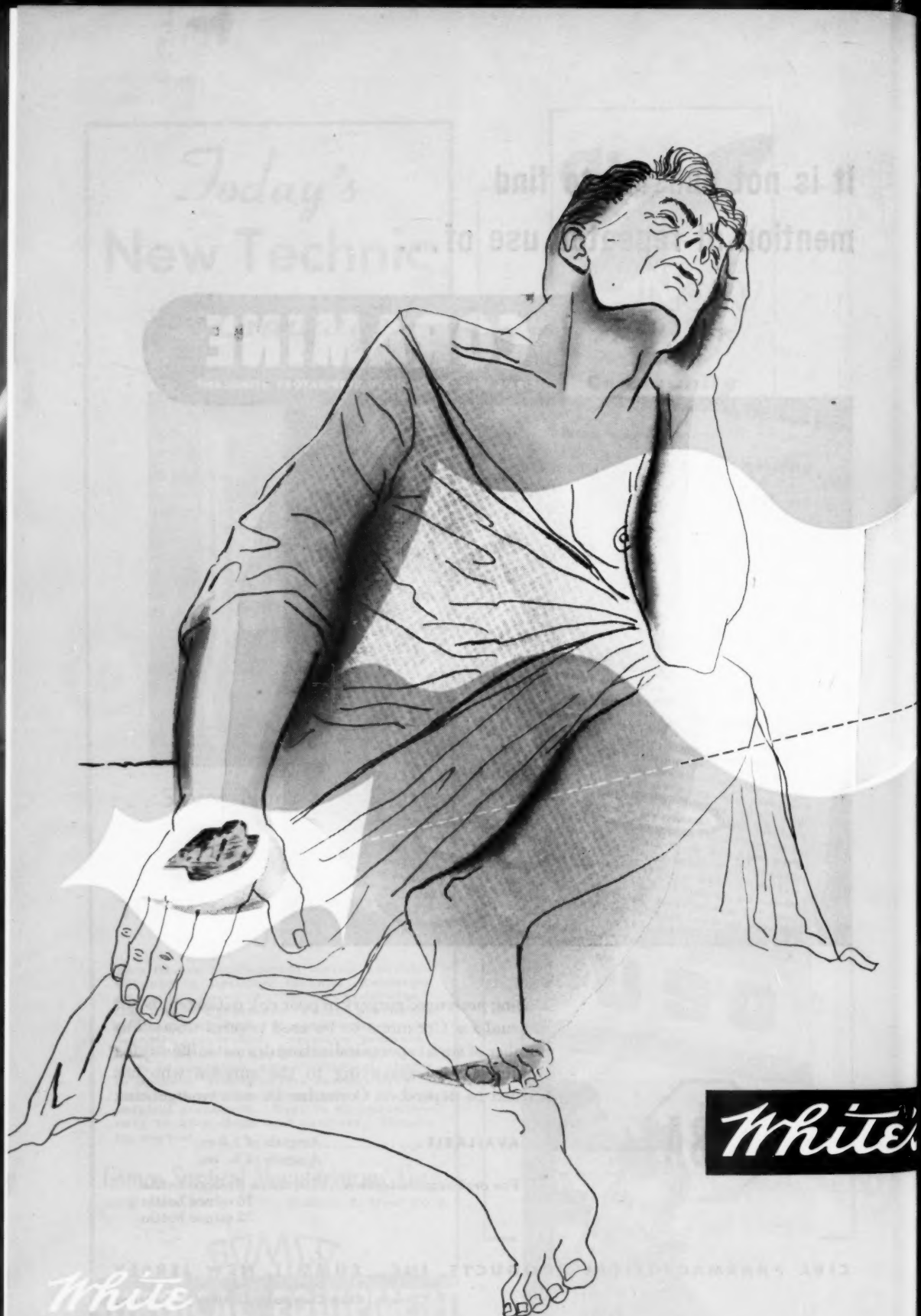


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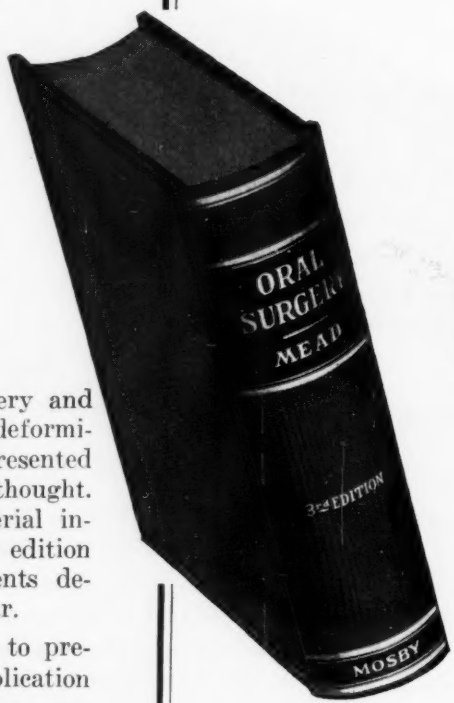


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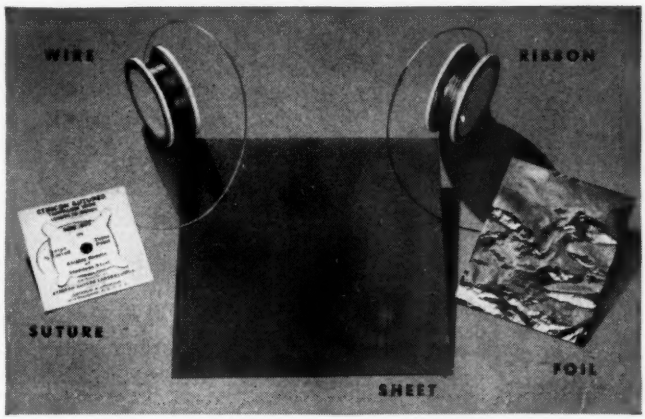


*Olson, C. T.: "The Place of Tantalum in Surgery," Industrial Medicine, 13: 917, November, 1944.

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# SURGERY

VOL. 20 SEPTEMBER, 1946 No. 3

## Original Communications

### TREATMENT OF EXTREMITIES FOLLOWING SUDDEN FAILURE OF CIRCULATION

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THERE is much evidence to indicate that the orthodox method of treatment of acute failure of circulation such as occurs in embolism, diabetes, senile or Buerger's gangrene, or injuries to major blood vessels and frostbite,[1] might be revised to advantage. The textbook treatment of such conditions, namely, elevation, heat, and mild antiseptic dressings, is a survival of the past, antedating Harvey's discovery of circulation of the blood and the increased knowledge of physiologic principles. Sydenham's recordings of the practices of Hippocrates indicate that in 410 B.C. he used the methods just described. It is probably fair to assume that Hippocrates did not know the physiology of circulation as we know it. His object in treatment was to hasten the formation of the line of demarcation and to facilitate the natural separation of the gangrenous from the adjacent living tissue, and his principles of elevation, and application of heat and embalming herbs, which are the textbook methods of treatment today, were quite effective in precipitating a pregangrenous condition into frank gangrene with the result which he desired. With the present knowledge of physiology, it would seem that the application of rational principles might prevent the advance of a pregangrenous condition and might set up conditions which would favor a return of circulation and survival of the part.

*Elevation.*—With impaired arterial flow into an extremity, elevation beyond the horizontal can easily set up conditions under which no blood may reach the periphery. This posture also empties the veins so that only the proximal capillaries of the extremity have any circulation passing through them. This is easily seen in cases of arterial embolism of the lower extremity. With the patient lying horizontally on the back, the toes and fore parts of the feet are elevated, and in the typical case are snow white in color while the thigh and leg regions, which are not elevated about the venous level of the trunk, are

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cyanotic and blotchy in color. If the affected foot is allowed to hang down, the blanched fore part becomes cyanotic and blotchy like the remainder of the leg. If it is elevated, it again returns to the blanched state. So, with elevation in the presence of impaired circulation, the vessels at the periphery may be completely empty.

The reflex which causes arterial constriction when the veins of extremities are emptied by gravity causes still further impairment of circulation by diminishing the caliber of those vessels that remain to supply arterial blood to the extremity. These two conditions, therefore, namely, elevation and arterial spasm, may prevent any blood from reaching the vascular tree beyond certain levels. Therefore, if the vascular tree is kept empty, there is no available supply of oxygen, and as each living cell has a limited number of hours that it can survive without oxygen, necrosis and gangrene are inevitable.

*Dependency.*—The absence of oxygen over a certain period causes changes in cells which are irreversible, so that even should the circulation be restored, the blood that enters the affected area will clot rapidly plugging up the whole vascular tree, which again completely deprives all cells of their oxygen supply and necrosis must be the end result. It is obvious then that if an extremity is without blood and becomes desiccated, it cannot possibly survive. On the other hand, if it is kept full of blood, no matter how venous the blood may be, provided it is not allowed to clot, there is some possibility of survival of the cells. If any circulation, no matter how slight an amount, is entering the proximal part of the extremity and is assisted by gravity to reach the periphery, and also by gravity the venous system is kept full, there will be some slight circulation at the periphery. This will give some interchange of fluids and, even though slight, will provide some oxygen interchange with the possible survival of the fixed cellular tissues and may prevent necrosis and gangrene. If with the dependent position of the extremity, cold is also applied, the requirement for oxygen can be cut down to the minimum and with good luck there may be sufficient circulation to provide the necessary oxygen under these conditions. Intravenous heparin[2] will prevent thrombosis in peripheral vessels and under these conditions may be of considerable value.

*Experiments.*—A series of experiments was undertaken to investigate the development of collateral circulation. The experiments were designed to determine if gravity would influence the survival of an extremity with impaired circulation, to give more time for the improvement of collateral circulation.

The experimental animals were dogs. After repeated tests, it was found that by ligation of aorta and a sufficient number of vessels going to the lower extremity, that the circulation could be impaired. This operation was carried out in a similar fashion in both the control and the experimental animals.

In alternating animals following the operation, the control was allowed to lie, stand, and walk about the cage with the extremity in the normal dependent position. In the other animal a posterior cast was applied surrounding the head, trunk, and affected extremity down to the phalangeal region of the foot. Much padding was used and great care was taken to not produce any point of pressure

over the trunk or involved extremity. In this plaster cast the experimental animals were nursed in the supine position with the affected extremity elevated vertically.

Another point to be considered is the fact that in control animals there was some exercise in walking about the cage while the experimental animals were kept at rest by the plaster cast.

The results were estimated on the incidence of gangrene occurring in the two groups. As in all experimetal work there were difficulties in obtaining a standard operation to produce the desired effect. Also the variety of blood supply in different animals added another uncertain factor in estimating the end result. In some of the animals developing gangrene, gas infection seemed to be a secondary invader and it was thought that this complication should not be excluded from the end result in the experiment in question.

It was realized also, in designing the experiments, that the short extremity with relatively little muscle distally and consequently with a less important blood supply was not a good parallel when considering the rather fleshy and large lower extremity of the human being. Moreover, the multitude of vessels which must be tied going into the lower extremity of a dog, to produce impairment of circulation when compared with the vascular failure seen in the human being when the femoral artery alone is occluded, also gives some indication of the difficulty in drawing conclusions from the experiment in such an animal.

With these points in mind, the experiments were undertaken and the results were roughly as follows. In control animals with the leg dependent, two out of ten animals developed gangrene. In the experimental animal where the leg was kept elevated, eight out of ten developed gangrene.

Although it is difficult to draw conclusions from the relatively small group of experiments and with the many other uncertain factors, there would seem to be a rather significant difference in the survival of the extremities when treated with the leg dependent compared with those treated postoperatively with the extremities elevated.

Fig. 1 and Tables I and II show the vessels tied, and the results of the experiments.

*Heat.*—Biologists have long been interested in the phenomenon of hibernation. It is common knowledge that the cold-blooded creatures, such as the snake and fish, or the warm-blooded creatures such as the bear and woodchuck, consume large quantities of nourishment when the sun is bright and temperatures are high, but when the temperatures fall their activity slows up and their intake is reduced until a state is reached in which these creatures may live for six months or more without taking food. This can happen because cellular metabolism is reduced with the fall in temperature.

The same principles can be applied to an avascular extremity (Allen).[3] When heat is added, the cellular metabolism is increased, resulting in the formation of increased amounts of metabolites giving an increased demand for oxygen. If no oxygen or flushing of metabolites is forthcoming, the period of survival of the cell is shortened. If, on the other hand, the cells are cooled, the requirement for oxygen is reduced and, under ideal conditions of cooling, the cells can

TABLE I. SERIES A: HINDLIMB FREE; NO CAST

| NUMBER | DATE OF OPERATION | WEIGHT (KG.) | SEX | OPERATOR | OPERATION NOTE | WOUND CONDITION | FIRST DAY WHEN LEG TEMPERATURE EQUAL | GANGRENE AND DAY OF APPEARANCE OF SIGNS | | | | | | CONTRACTURE | CONDITION OF LEG IN 3 WK. | AUTOPSY | BACTERIOLOGIC FINDINGS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | GANGRENE | CREPITATION | SWELLING | DISCOLORATION | ODOR | ULCERATION | | | | |
| A-1 | 10/16/43 | 9 | F | J. S. | Took 2¾ hr.; repeated anesthetic | Slight infection | 5 | 0 | | | | | | | Contracture in 2 wk. | | |
| A-2 | 10/17/43 | 8.1 | M | N. W. | Removed urine with syringe | Infection | 6 | 0 | | | | | | 0 | Normal | | |
| A-3 | 10/24/43 | 10.3 | M | J. S. | Used left leg; removed urine | Infection | | 3 | 3 | 3 | 3 | 3 | 3 | | | Gas gangrene—bacilli seen in muscle sections | B. welchii and Staph. aureus |
| A-4 | 10/24/43 | 10 | M | N. W. | Usual—1 hr., 50 min. | Infection | 6 | 0 | | | | | | 0 | Normal | | |
| A-5 | 10/31/43 | 8 | M | J. S. | Removed urine; spleen large | No infection | 4 | 0 | | | | | | 0 | Normal | | |
| A-6 | 11/ 1/43 | 10 | M | J. S. | No assistant; removed urine; 2 hr., 40 min.; much blood loss | No infection | 5 | 0 | | | | | | 0 | Normal | | |
| A-7 | 11/ 4/43 | 7.8 | M | N. W. | Removed urine | No infection | | 3 | 3 | 3 | 3 | 3 | 4 | | | Gas gangrene | B. welchii and Str. hemolyticus |
| A-8 | 11/ 7/43 | 6.5 | F | N. W. | No assistant; removed urine | No infection | 5 | 0 | | | | | | 0 | Normal | | |
| A-9 | 11/14/43 | 10.7 | F | N. W. | Removed urine; no assistant; breasts bled | No infection | 4 | 0 | | | | | | 0 | Normal | | |
| A-10 | 11/21/43 | 5.6 | M | J. S. | Removed urine; extra anesthetic into femoral vein | Infected | 5 | | | | | | | 0 | Normal | | |

TABLE II. SERIES B: HINDLIMB ELEVATED IN CAST

| NUMBER | DATE OF OPERATION | WEIGHT (KG.) | SEX | OPERATOR | OPERATION NOTE | WOUND CONDITION | FIRST DAY WHEN LEG TEMPERATURE EQUAL | GANGRENE AND DAY OF APPEARANCE OF SIGNS | | | | | | CONTRACTURE | CONDITION OF LEG IN 3 WK. | AUTOPSY | BACTERIOLOGIC FINDINGS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | GANGRENE | CREPITATION | SWELLING | DISCOLORATION | ODOR | ULCERATION | | | | |
| B-1 | 12/19/43 | 6.2 | F | N. W. | Removed urine | No infection | | +4 | 7 | Sl. 8 | 8 | 4 | 0 | | | Gas gangrene; pressure sores | B. welchii and Staph. aureus |
| B-2 | 12/20/43 | 5.6 | F | J. S. | Clear fluid in peritoneal cavity | No infection | | +3 | 3 | 3 | 4 | 3 | 0 | | | Gas gangrene | No growth |
| B-5 | 12/30/43 | 9.2 | F | N. W. | Removed urine | No infection | | +6 | | 6 | 6 | | 9 | | | Dry gangrene | B. welchii and coli in swab from ulcer |
| B-7 | 1/15/44 | 5.5 | F | N. W. | Small incision; no urine removed; heavily padded cast | Infected, local | | + | | | 6 | | | | | Gangrene; pus in foot | |
| B-8 | 1/23/44 | 7.4 | F | J. S. | | Infected, slight | | +6 | 6 | 7 | 6 | 6 | | | | Gas gangrene | B. welchii |
| B-10 | 1/29/44 | 10.8 | F | J. S. | Removed urine; sulfathiamide in wound | No infection | | +9 | | | | | 9 | + | | Gangrene; dry with sloughing | |
| B-11 | 2/ 6/44 | 7 | F | N. W. | Usual; removed urine | Infected | 8 | 0 | | | | | | 0 | Normal | | |
| B-12 | 7/13/44 | 10.5 | F | J. S. | Removed urine; left hypogastic not ligated | Infected | 2 | 0 | | | | | | 0 | Normal | | |
| B-13 | 10/19/44 | 10 | F | N. W. | Closed with interrupted sutures | Infected | | +6 | 6 | 6 | 6 | 0 | 0 | | | Gas gangrene | No clostridia |
| B-14 | 10/24/44 | 9.3 | F | J. S. | | No infection | | +14 | 0 | 0 | 0 | 14 | 0 | | | Dry gangrene; toes sloughed | |

survive long periods of time as can be demonstrated by refrigeration of tissue cultures, skin grafts, and various other tissues. The degree of cooling must be controlled to avoid a level, below which oxygen interchange may be inhibited.

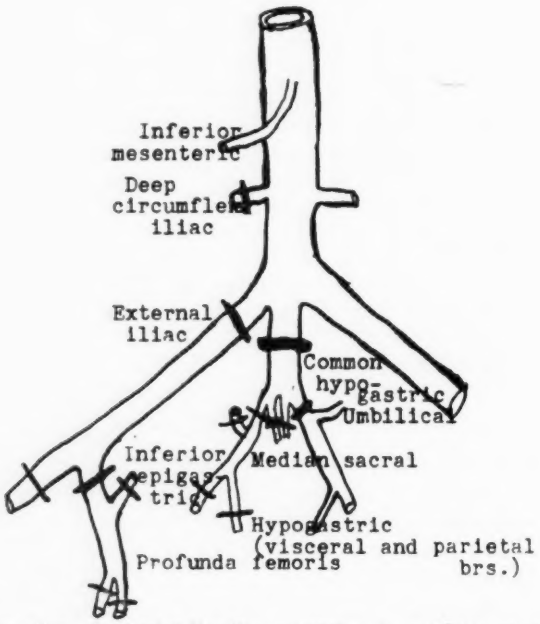


Fig. 1.—Indicating the sites of arterial ligation necessary to produce gangrene of an extremity of an animal.

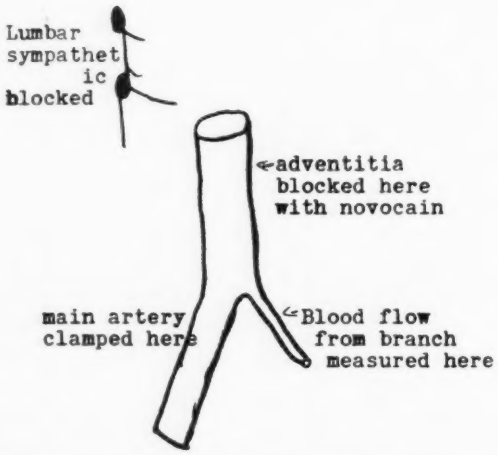
Lumbar sympathetic blocked
adventitia blocked here with novocain
main artery clamped here
Blood flow from branch measured here

Fig. 2.—Schematic drawing indicating method by which the blood flow was determined and the sites at which nerve block was carried out.

*Relaxation of Arterial Spasm.*—The application of heat to the trunk or other extremities is beneficial, causing reflex dilatation elsewhere in the vascular tree as demonstrated by the Landis and Gibbon[4] test. Some direct attempts to produce dilatation of the vascular tree may be made by novocain block of the lumbar sympathetic trunk. Under some conditions this ganglionated trunk is

resected, thereby relaxing all vasoconstriction in vessels going to the lower extremity. In the upper extremity a similar attack may be made on the preganglionic fibers of the stellate ganglion.

Experiments have been done to show that lumbar novocain block or periarterial block causes an increased flow of blood through collateral vessels when the main artery is obstructed. To avoid conjecture necessary when using the thermocouple, dye-circulation time, and other means used for estimating blood flow experiments were done by measuring the amount of blood that poured from the end of a divided collateral vessel after blocking the main trunk. In Table III are shown samples of the effects of such experiments.

TABLE III. BLOOD FLOW FROM DIVIDED COLLATERAL

| EXPERIMENT NUMBER | MAIN ARTERY OPEN CONTROL (IN C.C.) | MAIN ARTERY CLAMPED (IN C.C.) | MAIN ARTERY CLAMPED; NOVOCAIN BLOCK OF ADVENTITIA (IN C.C.) |
|---|---|---|---|
| 1 | 5 | 4 | 11 |
| | 8 | 5½ | 16½ |
| | 7½ | 4 | 15 |
| 2 | 9 | 10 | 18½ |
| | 8 | 9 | 19 |
| | 7 | 8½ | 20½ |

In forty-two such experiments similar results were obtained in all.

With proof that the flow through collaterals may increase from two-, three-, to fourfold in some cases, it is quite possible that the added flow provided by relaxing arterial spasm, under the conditions of dependency, and with a cool extremity, might tip the balance in favor of survival of the extremity.

The use of drugs such as alcohol and papaverine may be of some value in providing vasodilatation.

Four patients with sudden acute obstruction of main arterial trunks not suitable for surgical repair were treated in this way with most satisfactory results. In all these cases it was thought that from the nature of the accident and the obvious effect in the extremities, that high amputation was inevitable. Treated according to the principles enumerated, none of the extremities was lost. The maximum loss of tissue in any was a terminal phalanx of a toe and in some there was no loss of tissue. The extremities have all survived to be useful in walking.

## CASE REPORTS

CASE 1.—A. P., aged 28 years, entered the hospital in August, 1941. This patient had an accident to the popliteal artery which caused complete occlusion. Within a few hours the fore part of the foot was white and the remainder of the leg below the knee was cyanotic and mottled when in the horizontal position. There was severe pain in the popliteal region extending halfway down the leg, with anesthesia and paralysis of all the muscles below the level of the knee. The anterior and posterior tibial arteries were not pulsating. The foot had an appearance very similar to that seen in embolism of the common femoral artery. When first seen at about six hours, it was considered that any operation on the popliteal vessels was not indicated because of the skin wound. There was grave doubt if the foot would survive.

*Treatment.*—The patient was placed in a semireclining position with the foot dependent over the side of the bed. Cold, in the form of cotton-covered ice bags, was applied to the foot and leg. Novocain block of the lumbar sympathetic chain was carried out. Within a few minutes the appearance changed. The foot, which had been white and shrunken, became bluish in color and slightly swollen. The coldness became less striking and within a few hours the leg to the level of the ankle was warm. The patient was nursed in this position for about three weeks. After four days some blisters appeared on the dorsum of the foot and toes and this in itself was evidence that there was at least some circulation in the foot and toes. At the end of three weeks it was quite evident that the circulation was improving and that amputation could be avoided. Subsequently, the patient was able to walk quite satisfactorily on the foot and the circulation, now one and one-half years later, is adequate although there is no palpable pulsation in peripheral vessels.

CASE 2.—J. K., aged 24 years, entered the hospital Oct. 1, 1941. Following an operation for osteomyelitis of the superior ramus of pubis, this patient within a few hours developed evidence of thrombosis of the femoral artery. The leg became cold to the upper third of the thigh. The foot was mottled and the toes were white. There were anesthesia and paralysis at the periphery. Pulsations in the femoral, popliteal, and anterior and posterior tibial vessels were absent. In the presence of an infected field, operation on the femoral vessel to remove the thrombus was contraindicated. The patient was put on treatment, hoping to avert a major disaster in the form of extensive gangrene of the extremity, which seemed inevitable. On treatment about to be described, the situation was improved considerably within a few hours and a very satisfactory end result was obtained. Gangrene to the level of the proximal phalanx of the great toe and of the tip of the second toe occurred. There were some spastic deformities in the form of a mild equinovarus resulting from poor posture during treatment. With correction of this, the patient was able to walk quite well on a foot which now has adequate circulation.

*Treatment.*—Soon after it was apparent that the circulation was impaired, the foot and leg were placed in a dependent position. Cold was applied to the extremity, and the lumbar sympathetic chain was blocked with novocain. Within twenty-four hours there was considerable swelling of the foot and even though it was cool it was not cold. Within seventy-two hours there were some blisters on the dorsum of the foot. Both the blisters and the swelling were evidence that there was still circulation in the foot. (The foot that is gangrenous becomes desiccated if it is not suppurating.) From that time on there was evidence of some improvement of circulation of the foot and leg. The areas in the great and second toes already described began to show signs of desiccation and eventually turned black. Within a few weeks lines of demarcation were obvious and presently these portions of digits separated. The stumps healed. The result was most satisfactory in what appeared to be an extremely critical case of acute failure of circulation.

CASE 3.—B. K., aged 20 years, entered the hospital Nov. 9, 1942. For about one year, following an injury, this patient had aching and pain in the left arm and forearm. For four months there had been stiffness of and inability to straighten the left arm. At this time it was noticed that the arm was blue and this involved the hand and finger tips. At other times the color would change to red and occasionally to a snowy white. This latter change could be initiated by elevating the hand above the head, but occasionally this blanching would occur with the arm in the dependent position. During the week preceding admission the changes in the hand became more striking with small areas of gangrene appearing at the tips of the index and middle fingers. There was intense pain in the hand during this time and so much stiffness that the hand was practically useless. The fingers, hand, and forearm were cold to the level of the elbow. There was no pulsation in the radial, ulnar, brachial, or axillary arteries. The subclavian artery was pulsating normally in the posterior triangle.

X-rays of the cervical region showed a congenital anomaly of the left first rib. The second rib was normal in all respects. The first one was incompletely ossified and had an appearance similar to that of an incomplete cervical rib.

*Operation.*—As it was considered that this might be a cervical rib syndrome, it was decided first to divide the scalenus anticus muscle. The operator who did this was impressed that the subclavian artery at this point was considerably compressed by a fairly massively developed muscle belly. He felt also that after division of the muscle the pressure was relieved. The vessel rolled downward and forward. Palpating with the finger through the incision it was demonstrated that the artery was pulsating proximal to this level but it was doubtful if there was any pulsation in the third portion of the subclavian artery.

In the forty-eight hours following the operation it was apparent that the circulation to the extremity was still further impaired. There was some extension of the gangrenous processes and there was more pain, stiffness, and blueness at a higher level in the hand.

The brachial artery was exposed through a short incision, and was found to be not pulsating. There was marked edema of the wall of the vessel and of all surrounding structures. A needle was passed into the artery and no blood was obtained. A portion of the artery was removed for biopsy and was found filled with a thrombus.

It was decided following this that a resection of the central communications of the stellate ganglion should be carried out. This was accomplished through a posterior incision and at the same time the abnormal first rib was resected from its tubercle, anteriorly to its point of attachment to the second rib, within one-half inch of the costochondral junction.

Following this operation the patient was placed in a position in bed, which would allow the arm to maintain a dependent posture, and cold in the form of ice bags was applied to the extremity. It was apparent within twenty-four hours, that the circulation to the extremity was considerably improved. The blueness was replaced by a faint pink color. The pain in the arm was less severe and within a few days it disappeared completely. The gangrenous patches on the tips of the fingers showed signs of separating and within a few days they came off leaving healing surfaces. Within a short time the trophic changes in the nails were replaced by healthy growth of nails at their bases.

In this complete occlusion of the main arterial trunk, the operation had an important place in helping restore the circulation. The dependent position of the hand with the application of cold probably played an important role in preventing more loss of tissue.

## CONCLUSIONS

In extremities with impaired circulation the best prospects for survival can be provided by keeping the extremity dependent, by the application of cold, and by using methods to effect maximum dilatation of the collateral vessels entering the extremities.

I am pleased to acknowledge the technical assistance of Mrs. Cynthia Crookston and Mr. W. Cowan during these experiments.

## REFERENCES

1. Murray, Gordon: Heparin in Surgical Treatment of Blood Vessels, Arch. Surg. 40: 307-325, 1940.
2. Murray, Gordon, Jaques, L. B., Perrett, T. S., and Best, C. H.: Heparin and the Thrombosis of Veins Following Injury, SURGERY 2: 163, 1937.
3. Allen, Frederick: Refrigeration Anesthesia for Limb Operations, Anesthesiology 4: 12-16, 1943.
4. Landis, E. M., and Gibbon, J. H., Jr.: Vasodilitation in the Lower Extremities in Response to Emersion of Forearms in Warm Water, J. Clin. Investigation 11: 1019-1036, 1932.

# GANGRENE FOLLOWING FRACTURE TREATED WITH HEPARIN, PAPAVERINE, AND INTERMITTENT VENOUS OCCLUSION

## Report of a Case; Reasons for Using Heparin

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THERE is no record of impending gangrene following fracture having been treated with heparin. We report this case because a successful result was not expected in gangrene so far advanced, and because heparin may be useful in similar civilian and military trauma, such as paratrooper's landing injury. And there are several kinds of war wounds complicated by thrombosis, in the treatment of which amputation is done for imminent or existing gangrene. In the field, heparin may be administered by intermittent intravenous injection every four hours, the dose being from 50 to 75 mg.

### CASE REPORT

N. G., a man 44 years old, fell eight feet from a scaffolding to a concrete floor at 10 A.M., May 21, 1943. Upon striking the floor in an upright position, his right foot struck some wood. The ankle turned abnormally, and he fell to the floor. He rose, but could not walk due to severe pain and immediate swelling of the right ankle. This accident occurred at Patterson Field of the Army Air Service Command near Dayton, Ohio. At the civilian dispensary there, x-ray examination showed a T-shaped, comminuted fracture of the tibia extending into the ankle joint. A hospital bed was not available, and for personal reasons, the patient chose to be transported by ambulance to Columbus, a distance of fifty-five miles. He left the Field at 2 P.M., and arrived at Grant Hospital, Columbus, at 4:20 P.M. In transit, the foot and leg were supported by pillows.

Roentgenograms taken on admission to Grant Hospital showed slightly more displacement of the fragments. The ankle and foot were swollen, but there were no abrasions or lacerations of the skin. Due to continuation of the swelling, immobilization of the fracture was not done that evening. Ice packs were applied intermittently throughout the night. As the swelling increased, he suffered intense, throbbing pain which was eased with morphine. He stated that since the accident he had no sensation in the great right toe.

The next morning, May 22 at 8:30 A.M., the fracture was immobilized in a circular plaster cast, extending from the base of the toes to the thigh. Immediately after the application of the cast, the plaster cut completely through to the wadding, throughout its length. In doing this, the surgeon made a cut in the anterior lower part of the leg (see **Fig. 1*A***). This accident required widening of the split cast in order to arrest hemorrhage and to dress the wound, so the cast was not tight from the beginning. None of the three physicians present noted any cyanosis of the foot before the application of the cast. The procedure was done with a preliminary dose of morphine, gr. ⅙, and with ethyl chloride induction and light ether anesthesia. The patient was awake when he returned to his room at 9 A.M.

The immobilization did not relieve the pain, for which he was given another dose of morphine, gr. ¼, at 1 P.M. At 4 P.M. the nurse noted that the toes of the right foot were very blue and cold, and he had apparently no sensation in the toes. The intern confirmed this observation and reported it to the surgeon, who ordered that the cast be spread open throughout its length. At 4:45 P.M. the circulation had not improved, and the cast was opened widely. At 6 P.M. the foot was still blue and cold. The patient was able to move the toes, but had no perception of ordinarily painful stimuli. The intern felt pulsation in the dorsalis pedis artery, but did not palpate the posterior tibial artery.

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Although the cast no longer functioned as a circular, immobilizing splint, but only as a posterior support, the patient complained bitterly of increasing throbbing pain, with a burning sensation throughout the lower leg, ankle, and foot. At 11 P.M. another dose of morphine, gr. ¼, was given. During the night hot-water bottles and heat from an electric light tent were applied intermittently. This made the foot feel warmer to the examiner, but did not improve the color.

Throughout May 23 to 26, the patient complained of "tightness," a "tight band around my ankle," "burning sensation," "swelling," and "throbbing pain." He was given morphine, in ¼ gr. doses, from four to seven times daily. On May 25 the plaster support was removed. The pulse and respirations were normal, but the temperature rose daily, to a high point of 102.6° F. on May 28.

Fig. 1*A*.—Oct. 10, 1943 (five months after injury). Note loss of nails and deformity of all toes, dorsal demarcation line across middle of dorsum and extending medially toward the heel (seen better in Fig. 2*A*). Tissues distal to this line are apparently still impaired. The mid-anterior lower leg scar resulted from the incision made when the plaster of the cast was cut.

On May 26 one of us (J. McL.) saw the patient for the first time. This examination revealed a greatly swollen ankle and foot.* The skin was thin and tight, and affected with fluid-filled vesicles varying in diameter from 1 to 5 cm. There was doubtlessly extensive deep hemorrhage. Palpation of the anterior and posterior tibial arteries gave no evidence of pulsation. The distal half of the foot was blue and cold, and the toes, particularly the great

*The injured foot and ankle appeared to be more than twice as large as the other foot and ankle. Measurements could not be taken due to the profusion of bullae.

toe, were the bluest and coldest part of the foot. A definite demarcation line was visible across the foot between the sole and the arch. This line extended posteriorly in the medial side of the arch (see Figs. 1*B* and 2*B*). Between the arch and the heel, the area felt cool and had a dusky reddish color. Only the heel was felt to have and appeared to have normal circulation. These areas were visible on Oct. 10, 1943, almost five months after the injury, and may be seen in the photographs taken on that date (Figs. 1*A*, 1*B*, and 1*C*).

*Pathology.*—Our concept of the pathologic condition was the following:

1. A T-shaped fracture of the tibia extending into the ankle joint (Fig. 1*D*).
2. Extensive hemorrhage into the ankle joint and surrounding tissues.
3. Severe contusion of the foot, ankle, and lower leg, with tissue cell damage and exudate.
4. Liberation of a large amount of thromboplastic substance (cephalin) from injured tissue cells and from blood cells and platelets, widely distributed in exudate and extravasated blood.

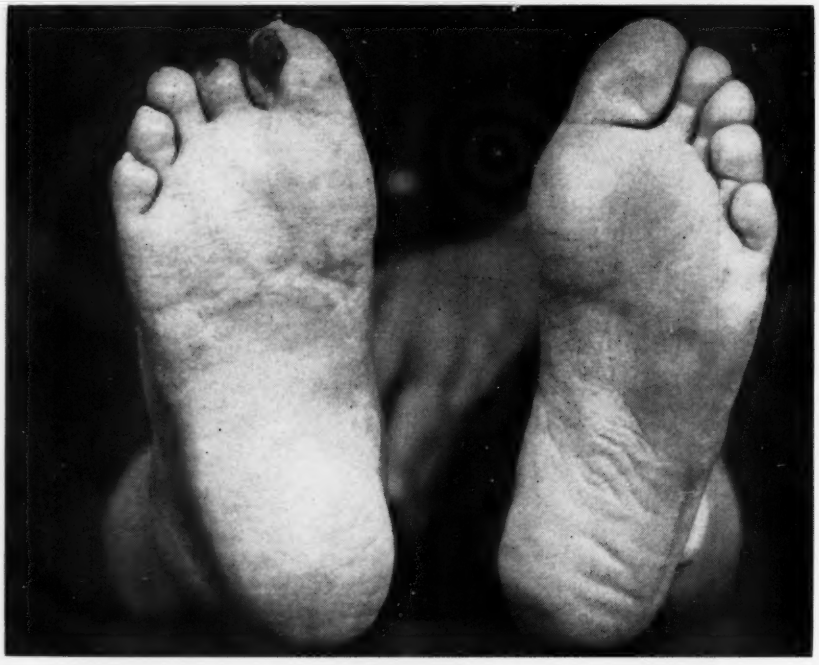

Fig. 1*B*.—Oct. 10, 1943 (five months after injury). Note demarcation line between the sole and the arch of the plantar tissues, which curves toward the heel on the medial side. Also notice "nobby" character and uneven texture of skin apparently covering nodules of subcutaneous tissue, and very slow healing in toes most affected. Finally there is still a slight difference between the appearance of the skin of the arch and lateral half of the heel, and that of the medial half of the heel.

5. Inadequate blood supply to all of the foot except the heel, with absence of the anterior and posterior tibial artery pulsation, possibly due to the following:
   (a) Deficient main artery circulation caused by pressure, thrombosis, thrombophlebitis, or laceration.
   (b) Impaired collateral circulation caused by pressure in contused tissues.
   (c) Vasoconstriction caused by the action of shed blood, or arterial muscle spasm due to nerve injury during the accident or consequent to thrombosis.
6. Adhesions resulting from the precipitation of fibrin due to the conditions 2, 3, and 4 just stated.

*Consideration of Treatment.*—1. In our opinion, the accidental cut (see Figs. 1*A* and 2*B*) made in the anterior part of the leg during the splitting of the cast had not severed the anterior or posterior tibial artery; hence, vascular suture was not indicated.

2. Multiple deep incisions into the ankle to relieve the pressure on the main vessels was considered. This procedure might have been advantageous shortly after the accident, but 125 hours later, on May 26, the danger of introducing infection (and possibly gas gangrene) into devitalized tissues was too great in the presence of advanced circulatory gangrene. Surgical judgment dictated that it was judicious to leave alone that which was bad enough.

3. Dismissing the idea of surgical intervention, it was decided to try to improve the circulation by the use of heparin, papaverine hydrochloride, and the principle of intermittent venous occlusion.* The papaverine was used for its effect in relaxing striated muscle of vessels, and the intermittent venous occlusion for its mechanical aid to circulation. Heparin was administered for the reasons to be given. It was hoped that this triple therapy might stop the advancing gangrene, but reliance could not be placed on its effectiveness to prevent the threatened amputation.

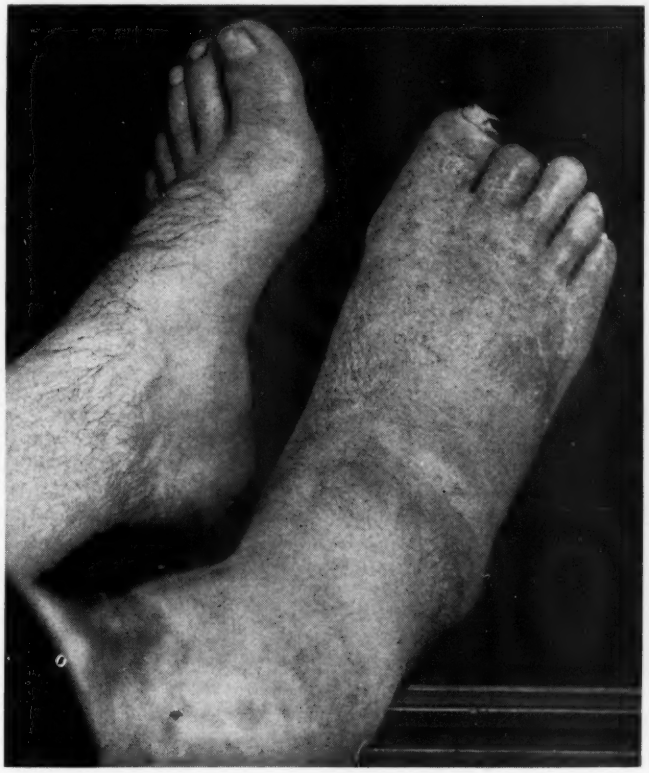

Fig. 1*C*.—Oct. 10, 1943. Demarcation line curving medially toward heel. Loss of tissue of toes, including nails. Abnormal shape of toes.

*Reasons for Using Heparin.*—Heparin was used to increase the fluidity of the blood as an immediate aid to the main and collateral circulation. The effects of heparin tending to improve the circulation were these:

1. The decrease in the density and viscosity of plasma.
2. The prevention of thrombus formation by platelets.
3. The preservation of platelets from disintegrating to liberate the clotting substance, cephalin.

*Lindgren and Wilander[1] reported a successful embolectomy for a 4½-day-old embolus with secondary thrombosis in the popliteal artery. The treatment of this patient included heparin, eupaverin, and the pavex apparatus. Linton[2] reported a case of acute major occlusion in which gangrene of the foot was avoided by the use of intermittent venous occlusion.

4. The prevention of "stickiness" of platelets and red blood cells.

5. Its effect in preventing adhesions which might cause impediments to the circulation by their pressure and constriction.

6. Its effectiveness in prolonging the coagulation time, even after clotting has begun, and in maintaining hemorrhage and exudate in a more fluid and absorbable state.

7. Its indirect effect in neutralizing the thromboplastic action of cephalin.

8. Its effect in promptly reducing the swelling and impaired collateral circulation associated with thrombophlebitis and phlebothrombosis.*

Fig. 1*D*.—Roentgenogram of fracture.

9. Its effect in restoring circulation in vessels affected with thrombosis.†

All of these effects of heparin are well known, and have been verified by many workers. The effect of increasing the fluidity of the blood was observed in the first (1916) preparation of this anticoagulant. Its effect in neutralizing the thromboplastic action of cephalin almost prevented its discovery.[3] In 1924 the value of the action of heparin (heparphosphatid)‡ in the prevention of experimental thrombosis and pulmonary embolism was first demonstrated.[4]

*In one case, thrombophlebitis in the neck following incision of a tonsillar abscess caused such swelling and intense pressure on the trachea that an emergency tracheotomy had to be done to relieve the dyspnea and cyanosis. The swelling and pressure subsided only after heparinization.

†In another case, phlebographs showed extensive obstruction due to a clot. Phlebographs taken two weeks after completion of heparinization, showed re-establishment of circulation. These cases will be published.

‡Heparphosphatid (and cuorin) were renamed antiprothrombin (Howell, W. H.: The Coagulation of the Blood: Harvey Lect., 1916-1917 Series, 273-324, 1917.) and antiprothrombin was renamed heparin (Howell, W. H., and Holt, E.: Two New Factors in Blood Coagulation, Heparin and Proantithrombin, Am. J. Physiol. **47**: 328-341, 1918).

*Prognosis.*—Judging by previous clinical experience, it did not appear possible for recovery to occur in a foot which had lacked adequate circulation for a period of five days and five hours, or 125 hours. With gangrene in parts of the toes, advanced impending gangrene with cyanosis and coldness in the distal half of the foot, a distinct demarcation line and impaired circulation in all of the foot except the heel, we expected that in spite of the treatment outlined, the end result would be amputation below the knee. Written in the record is the notation: "It is pretty late after the original injury to expect very much."

*Treatment and Clinical Course.*—The apparatus for producing intermittent venous occlusion was operated for forty-five minutes every four hours during the sixteen days from May 26 to June 11. The papaverine was administered from May 26 to June 2 in doses of ¼ gr. every four hours at first, and later, every six hours. A total of 7¼ gr. was given.

Heparin administration was started at 5 P.M. on May 26, and discontinued on June 2 at 9:15 A.M. This is a period of 160 hours of heparinization; however, the needle came out of the vein several times. Due to lack of intern service, it could not always be reinserted promptly, and we estimate that five hours approximates the total time the intravenous drip was interrupted. During these periods the coagulation time was lowered, but did not arrive at the preheparinization coagulation time of three and one-half minutes. At times the patient was irrational, and most of the time he was in an angry mood from pain. He made attempts to remove the needle from the vein of the right ankle, thus we could not tie a ball-tipped cannula into the vein of the uninjured ankle.

Four ampules of heparin* solution (400 mg. of heparin in 40 c.c. of saline solution) were added to 1,000 c.c. of Ringer's solution and administered at an average rate of about 25 drops a minute. The coagulation time desired (between fifteen and thirty minutes) was difficult to maintain. More heparin was used than is usually required to yield a clotting time between fifteen and thirty minutes. The patient received a total of 46¼ ampules of heparin solution, or 4.625 Gm. of heparin administered in a total of 12,250 c.c. of normal saline and Ringer's solution—a daily intravenous fluid intake of 1,850 c.c. which did not produce edema. For the details of the administration of heparin and clotting times see Table I.

*Progress.*—During May 27 and 28, the temperature continued to mount, and the patient was irrational at times, but he required much less morphine in spite of the discomfort caused by the various treatments. There was no definite visible improvement in the color or the temperature of the foot or ankle. On May 27 many of the bullae broke, so it was possible to secure a measurement at the level of the external malleolus, this being 13½ inches. At the same level the left ankle measured 9¾ inches.

Throughout heparinization the sites of the broken bullae exuded dark, red fluid copiously, as though this fluid (heparinized ?) percolated through the tissues from their depths to the surface. After heparinization stopped, oozing stopped, and the areas became epithelized promptly.

On May 29, after three days of this triple treatment, the toes appeared less cyanotic and felt warmer. The temperature receded gradually, arriving at normal on June 2. The ankle and foot were less swollen, the measurement being 1½ inches less than previously. On May 30 further improvement was noted; the patient was no longer irrational and required very little morphine.

On May 31, all examiners agreed that the foot was definitely warmer and of much better color. Even the great toe, although almost black in color, felt warmer. One this day, May 31, at 2:30 P.M. hematuria was noted for the first time. This occurred after the administration of 3.5 Gm. of heparin in about 112 hours. But as the temperature was steadily receding from its peak on May 28, as the swelling was subsiding, the pain lessening, and the circulation unmistakably improving, it was decided to continue heparinization, for it now appeared possible to avoid the threatened amputation of the foot, although the toes still seemed destined for death. Blood counts were taken to estimate the amount of blood lost in the urine.

On June 2 the pulse in the posterior tibial artery became palpable. The temperature became normal and remained there until the patient's discharge on July 17. The color of the

*Heparin is manufactured by the Hoffmann-La Roche, Inc., Nutley, N. J., and is sold under the trade name of "Liquaemin."

foot was almost "pink," and most of each toe was lighter in plum shade as contrasted with that of the previous bluish-black color. The patient had very little discomfort and no more morphine was required.

The loss of blood in the urine was not severe. As the posterior tibial pulsation was definitely re-established and the condition of the foot and akle so much better, the heparin

TABLE I. DETAILS OF HEPARIN ADMINISTRATION AND COAGULATION TIMES

| 1943 | HOUR | HEPARIN SOLUTION | DROPS PER MINUTE | COAGULATION TIME (MINUTES) |
|---|---|---|---|---|
| May 26 | 5:00 P.M. | 400 mg. in 40 c.c. plus 1,000 c.c. saline | 20 | 3½ |
| | 6:00 P.M. | | 30 | 8½ |
| | 7:00 P.M. | | 30 | 8 |
| | 9:00 P.M. | | 20 | 17 |
| | 12:00 Midnight | | 25 | 11½ |
| May 27 | 3:00 A.M. | | 27 | 14½ |
| | 6:00 A.M. | | 20 | 16½ |
| | 6:30 A.M. | 300 mg. in 30 c.c. plus 750 c.c. saline | | |
| | 9:00 A.M. | | 30 | 18 |
| | 11:30 A.M. | 400 mg. in 40 c.c. plus 1,000 c.c. saline | | |
| | 12:00 Noon | | 37 | 19 |
| | 3:00 P.M. | | 32 | 30 |
| | 6:00 P.M. | | 22 | 42 |
| | 8:30 P.M. | 200 mg. in 20 c.c. plus 750 c.c. saline | (added to 150 c.c. of previous solution) | |
| | 9:00 P.M. | | 20 | 30½ |
| | 12:00 Midnight | | 20 | 19½ |
| May 28 | 3:00 A.M. | | 25 | 10½ |
| | 6:00 A.M. | | 20 | 19½ |
| | 7:45 A.M. | 200 mg. in 20 c.c. plus 750 c.c. | 20 | |
| | 9:00 A.M. | | 22 | 16½ |
| | 12:00 Noon | | 20 | 15 |
| | 3:00 P.M. | | 20 | 17½ |
| | 6:00 P.M. | | 20 | 7 |
| | 7:15 P.M. | 300 mg. in 30 c.c. saline plus 750 c.c. Ringer's | 30 | |
| | 9:00 P.M. | | 35 | 5 |
| | 12:00 Midnight | | 32 | 15 |
| May 29 | 2:15 A.M. | 400 mg. in 40 c.c. saline plus 750 c.c. Ringer's | 25 | |
| | 3:00 A.M. | | 15 | 32½ |
| | 6:00 A.M. | | 15 | 26 |
| | 9:00 A.M. | | 15 | 17 |
| | 12:00 Noon | | 14 | 30 |
| | 3:00 P.M. | | 16 | 14 |
| | 5:00 P.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 16 | |
| | 6:00 P.M. | | 16 | 10½ |
| | 9:00 P.M. | | 25 | 35½ |
| | 12:00 Midnight | | 20 | 44½ |
| May 30 | 3:00 A.M. | | 16 | 5 |
| | 6:00 A.M. | | 20 | 11 |
| | 9:00 A.M. | | 20 | 4½ |
| | 10:30 A.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 28 | |
| | 12:00 Noon | | 28 | 20½ |
| | 3:00 P.M. | | 16 | 18 |
| | 6:00 P.M. | | 22 | 7½ |
| | 9:00 P.M. | | 22 | 9 |
| | 12:00 Midnight | | 22 | 11 |

TABLE I—CONT'D

| 1943 | HOUR | HEPARIN SOLUTION | DROPS PER MINUTE | COAGULATION TIME (MINUTES) |
|---|---|---|---|---|
| May 31 | 12:55 A.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 22 | |
| | 3:00 A.M. | | 22 | 34 |
| | 6:00 A.M. | | 18 | 12 |
| | 9:00 A.M. | | 18 | 7 |
| | 12:00 Noon | | 25 | 4 |
| | 3:00 P.M. | | 40 | 13 |
| | 5:50 P.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 40 | |
| | 6:00 P.M. | | 38 | 6 |
| | 9:00 P.M. | | 45 | 25 |
| | 12:00 Midnight | | 40 | 35 |
| June 1 | 3:00 A.M. | | 30 | 26½ |
| | 3:40 A.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 30 | |
| | 6:00 A.M. | | 30 | 27 |
| | 9:00 A.M. | (Error in coagulation time technique) | 25 | ? |
| | 10:00 A.M. | (Coagulation time checked) | 25 | 10 |
| | 12:00 Noon | | 24 | 15 |
| | 3:00 P.M. | | 22 | 9 |
| | 6:00 P.M. | | 25 | 8½ |
| | 7:10 P.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 40 | |
| | 9:00 P.M. | | 40 | 23 |
| | 12:00 Midnight | | 40 | 25 |
| June 2 | 3:00 A.M. | | 40 | 29 |
| | 5:15 A.M. | 400 mg. in 40 c.c. saline plus 1,000 c.c. Ringer's | 40 | |
| | 6:00 A.M. | | 40 | 21 |
| | 9:00 A.M. | Heparin discontinued | 38 | 24 |
| | 12:00 Noon | | | 6 |
| | 6:00 P.M. | | | 3 |

and papaverine were discontinued on June 2. It would have been continued for a few more days if the hematuria had not occurred.

From June 2 to June 28 the condition slowly bettered. The toes which had seemed fated for mortification regained adequate circulation, except in certain distal areas which became more circumscribed and remained black in color.

On June 28 a sketch was made of the foot indicating these necrotic areas (see Figs. 3 and 4) which proved to approximate the final result when compared with the photographs taken on Oct. 10, 1943 (Figs. 1*A* and 1*B*), and those taken on April 15, 1944 (Figs. 2*A* and 2*B*). Dead black skin, with some necrotic subcutaneous tissue, was removed from the toes from time to time, and the last of the black toenails dropped off on June 10. None of the nails thereafter grew normally (see Figs. 1*A*, 1*C*, and 2*A*).

On June 6, the patient sat up in bed; on June 14 he was on the hospital porch in a wheel chair, and on June 28 he walked with crutches and the aid of an orderly.

On July 4, bone was exposed at the tips of the second and fourth toes, but he lost only a spicule or so from these areas. He was discharged from the hospital on July 17 and returned to light work, as a supervisor, on Sept. 20, 1943. Upon discharge, he had no sensation in the foot except in the heel. In September, he noted returning sensation in the lateral side of the foot—a tickling sensation when drawing on a sock. Figs. 1*B*, 1*C*, 2*A*, and 2*B* show that the lateral side of the foot was less affected than the medial side, by the impaired circulation.

At a follow-up examination on Oct. 10, 1943, he had some sensation in all of the foot except the great toe. All of the nails were deformed. The ankle was still considerably swollen, but had surprisingly good function.

The patient was again examined April 9, 1944, and photographs taken on April 15, 1944 (Figs. 2*A* and 2*B*). The demarcation line was still visible at this time. The foot was almost normal in size upon awakening in the mornings but increased considerably after he had been up for a while. The ankle, the site of the unreduced fracture still remained large. Sensation returned to the entire foot, including the great toe; in fact, the sensation was normal throughout and his reaction to "tickling" the foot was normal. He has worked every day since his first return to work on Sept. 20, 1943. He drives his car daily for long distances, supervising work in near-by cities; and walks without the aid of crutches or cane, although he has a large shoe for the affected foot. He feels that the condition is still improving, the swelling during the day is less, and he is well satisfied with the result.

Fig. 2*A*.—April 15, 1944 (eleven months after the injury). Demarcation line persists, with medial extension toward the heel. Tissues distal to it appear to be abnormal in form and nutrition. Epithelization of toes almost complete, but imperfect. Compare with Fig. 1*C* for size and shape of foot. Ankle still swollen.

## DISCUSSION

*Gangrene.*—We have reported the facts of the case. It is difficult not to include in this paper a statement concerning our utter surprise or astonishment in witnessing gradually returning viability in tissue affected with gangrene, imminent gangrene and impending gangrene.

We all judged, on May 26, after more than five days of severe inadequate blood circulation in most of the foot, that the end result would be amputation

of the lower leg for gangrene of the foot; we gave the treatment with the hope, but not with the expectation, of obtaining the result recorded.

This result has made us wonder how long tissue can be deprived of blood circulation sufficient to maintain normal viability and then recover, after administration of the treatment given. In general, clinical experience has shown that recovery cannot be expected after forty-eight hours lack of blood.

This case also brings up the question of what are the physical and chemical changes associated with the three states which we described clinically in this case; namely, *gangrene* of the toes, *imminent gangrene* of the distal half of the foot limited proximally by a distinct line of demarcation on the plantar and dorsal surfaces, and an area of *impending gangrene* involving the rest of the foot (except the heel). We pictured the pathology as a combination of dry gangrene (arterial supply defect) and moist gangrene (venous thrombosis).

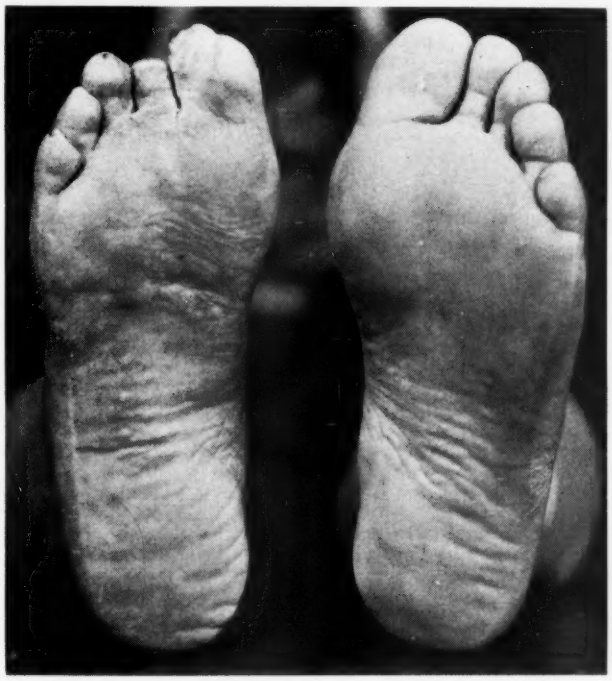

Fig. 2*B*.—April 15, 1944 (eleven months after injury). Demarcation line with medial extension persists. Epithelization of toes is almost complete, but crude. Note in distal tissues, especially the toes, a "budding" as if formed from cells which lived, whereas others near by presumably died.

If the definition of gangrene is tissue death, it is difficult to understand how the toes, particularly the great toe, is live tissue today. That profound changes of tissues of the distal half of the foot, and very profound changes in tissues of the toes—changes toward death, if not to death—occurred appears evident to us, first, from the clinical signs we saw and felt, and second from the state of the tissues one year after the injury, which is partly shown in the illustrations.

If this distal half of the foot now appeared as normal as the other foot (shown for comparison) one might properly question our categories of gangrene, imminent gangrene and impending gangrene.

That which we described as impending gangrene (the cool, livid colored arch, proximal to the demarcation line) apparently has regained normal circulation, temperature, and sensation, as has the distal half of the foot, but the skin of the distal half is not normal (as is shown in Figs. 2*A* and 2*B*) and the demarcation line is still visible, although it no longer separates cyanotic from less cyanotic tissue.

The toes may be observed in Figs. 1*A*, 1*B*, 1*C*, 2*A*, and 2*B* and those of the injured right foot compared with those of the left foot. The loss or deformity of the nails is evident and is evidence of poor recovery of matrix cells from deficient nutrition, or evidence that some of the matrix cells did die and not enough survived to produce normal nails. But the profound changes approaching near death are perhaps best illustrated by the inability of the toes, even after a year since the accident and after six months of use in work, to regain their normal form, compared with the normal toes of the left foot. On May 26 and 27, the great toe, and parts of the other toes, seemed gangrenous in our opinion, that is, necrotic beyond the power of recovery.

Fig. 3.

Figs. 3. and 4.—Dorsal and plantar views. June 28, 1943 (five weeks after injury, and twenty-six days after cessation of treatment). Drawings to indicate what was thought at that time would be the final tissue loss.

If one argues that this is not true, that we were mistaken in our judgment of what was gangrenous, and that the only truly gangrenous tissue was that which finally remained black and was excised or dropped off, how does one account for the misshapen toes which might be said to appear as though formed by budding from rests of cells retaining sufficient vitality for mitosis—a sort of regeneration of the toe.

And in clinical gangrene do all of the tissues (skin, subcutaneous tissue, vessels, nerves, and bone) die at once? The point we are trying to make is that even in clinical gangrene (as well as imminent and impending gangrene) there

is a point before all of the cells die at which treatment may restore the member, although in somewhat imperfect form.

Perhaps the same principle is at work in the successful use of heparin in mesenteric thrombosis. The heparin can effect a release from imminent gangrene in the adjacent gut portions not excised.

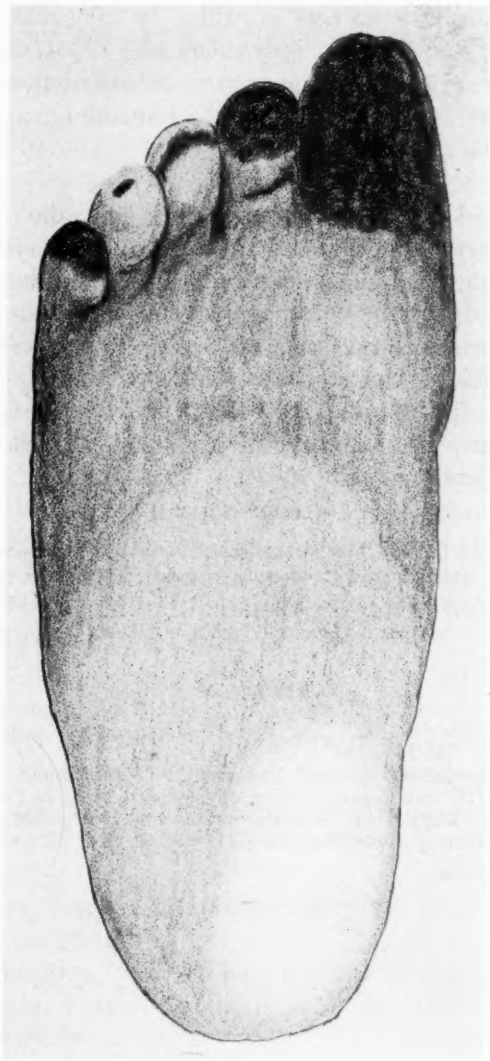

Fig. 4.

*(For legend see opposite page.)*

This case, after more than five days of deficient circulation, and Lindgren and Wilander's case (embolus with secondary thrombosis) after four and one-half days, may cause us to revise our judgment on the possibility of recovery in gangrenous tissue caused by deficient blood circulation. Possibly animal experimentation could add to our knowledge on this subject.

*Adhesions.*—Another point which might be commented on here is the degree of function present in the ankle, foot, and toes. Considering the severity of the original injury, the untreated fracture into the ankle, the hemorrhage, the edema, and the tissue changes in the various degrees of gangrene, as well as the months of disuse, there is a remarkable freedom from crippling adhesions, the function of the ankle and foot being very good. This suggests that heparinization following various operations, the success of which is frequently cancelled by postoperative adhesions at the site of operation, may be of value. The results in such operations as nerve and tendon suture, reconstruction surgery in general, and certain orthopedic operations might be improved.

## SUMMARY

A case is reported in which gangrene developed in the foot following trauma (including tibial fracture). Five days and seven hours after the injury, treatment by intermittent venous occlusion, papaverine, and heparin was begun, although at this time it appeared that amputation might be necessary eventually. The final tissue loss was small portions of the ends of the toes and all of the nails. Amputation was avoided and a satisfactory functioning foot obtained.

Recovery from clinical gangrene with this treatment is discussed, and it is suggested that heparin might be useful in preventing adhesions in certain reconstruction operations.

## ADDENDUM

Aug. 13, 1946. The patient has worked continuously since Sept. 20, 1943, being on his feet most of the time. Swelling of the foot is worse at night, but he is able to wear a pair of shoes if the right foot shoe is made a little larger by stretching. There is still good function, with no late adhesions. He has no pain, and no skin ulcers have developed. He limps somewhat.

## REFERENCES

1. Lindgren, S., and Wilander, O.: The Use of Heparin in Vascular Surgery, Acta med. Scandinav. **107**: 148-160, 1941.
2. Linton, Robert R.: Peripheral Arterial Embolism, New England J. Med. **224**: 189, 1941.
3. McLean, Jay: The Thromboplastic Action of Cephalin, Am. J. Physiol. **41**: 250-257, 1916.
4. Mason, E. C.: Blood Coagulation. The Production and Prevention of Experimental Thrombosis and Pulmonary Embolism, Surg., Gynec. & Obst. **39**: 421-428, 1924.

# HYDRONEPHROSIS

## IV. The Surgical Treatment

Frank Hinman, M.D., San Francisco, Calif.

THE only cure of hydronephrosis is the removal of the obstruction causing it. The first principle in the treatment, therefore, is diagnosis. This means information not only of reality but of cause, degree, and complexity. The renal changes of back pressure may be on one side only or they may be bilateral. The obstruction to urinary flow may be in the upper or the lower part of the tract, even at the urethral meatus. The changes of back pressure then would have ascended progressively from below upward, affecting first the urethra, then the bladder, then one or both ureters, and finally the corresponding kidney or kidneys. In any case the hydronephrosis itself may be small or large and, if bilateral, very much alike on both sides or one side markedly different from the other in degree. Finally, the renal parenchyma in addition to hydronephrotic atrophy may be damaged by an acute, a chronic, or an atrophic pyelonephritis, or by something else, and the renal pelvis in addition to ectasis also may have infectious changes such as pyelitis cystica or other complication. The primary cause of urinary obstruction may produce changes elsewhere which in time add to the degree of the renal obstruction independently so that treatment must take into account these secondary factors in order to be effective. Clearly, a complete diagnosis is the first principle of treatment.

With diagnosis complete, sometimes no small accomplishment, the problem of treatment then presented may be so complex that the best judgment even of an expert may not solve it correctly. Occasionally noninterference is a wise decision. Usually there is a choice between doing one or more of several different things. Always the aim will be preservation of renal tissue with the least risk. Experience in failure and success has set up only a few general rules, each with exceptions.

The diagnosis discloses the following facts:

I. About the condition
   - A. The location, whether unilateral or bilateral
   - B. The degree, whether slight, moderate, or advanced
   - C. The complications
     1. Renal
        - (a) Infection, whether slight, chronic, or atrophic at this stage
        - (b) Some other abnormality (1) of the hydronephrotic kidney, such as stone or tumor, etc., or (2) of its mate (which may even be absent)
     2. Urogenital, coincidental, or related abnormality

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II. About the obstruction
   A. Its location; whether the condition causing obstruction is infravesical or supravesical
   B. Its nature, whether extrinsic or intrinsic, and whether single or multiple
   C. Its complications in the way of secondary changes of back pressure in other parts of the tract which have themselves now become obstructive, such as a vesical diverticulum or an elongated tortuous hydroureter, etc.

At once one recognizes two types: an insular hydronephrosis, an isolated pyelectasis and hydronephrotic atrophy of pure ureteropelvis origin, and a hydronephrosis similar pathologically but due to obstruction and accompanied by changes below the ureteropelvic junction.

The treatment of the idiopathic unitary or essential type of hydronephrosis during the past twenty years has stimulated urologic ingenuity to the point that now the surgical methods of repair are almost perfect and many specialists confidently attempt the repair of any advanced hydronephrosis not completely functionless (see Deming). This point of view is vulnerable. Why save a kidney which will always be an accessory of its mate, never capable alone of performing total function in the event that it would be called on by the loss of this mate to do so later? Death from renal insufficiency would be as certain as when nephrectomy had been performed originally instead of the repair. The surgery may have been perfect but has added nothing to the future security of the patient. If the surgeon determines beforehand, however, that an uninfected hydronephrotic kidney is capable of performing anything near one-fourth to one-fifth of total function and that after relief of the obstruction the renal parenchyma of the hydronephrotic kidney has reserve potentialities which would permit its renal units to hypertrophy upon stimulation as would happen when some disaster struck its compensatory mate (it might hypertrophy even to the degree of carrying total function efficiently with complete loss of its mate), then he has good reason to repair the hydronephrotic kideny and by so doing adds something to the future security of the patient. This rule applies to the patient with an uncomplicated unilateral hydronephrosis, the opposite kidney never having been injured or diseased and being now compensatory. Anything at all abnormal with it changes the problem. This abnormality might better be corrected first. If it also is hydronephrotic from a similar ureteropelvic obstruction but to a lesser degree, bilateral ureteropelvic repair may be indicated. If bilateral, should the hydronephrosis of mild degree or the hydronephrosis of advanced degree be repaired first? Repair of the poor side first is the rule because (1) postoperative renal insufficiency and the danger of anuria will be less and (2) an optimal degree of repair of both kidneys will be secured. Repair is hypertrophy in response to stimulation. Therefore, after repair of the good side first, the poor side later might get little or no stimulation and the end result in renal reserve power would be much less than after repair of the poor side first, which would get its maximum stimulation and build up a reserve during the period of lessened function following the surgical repair of the good kidney.

In the event of a decision to perform a bilateral repair, the second operation should not be delayed too long. Prolonged renal readjustment after the first repair, say, of the right kidney, might so alter the potentialities of the right and left kidneys as not only to lose the opportunity of an optimal degree of bilateral repair but even to make left nephrectomy preferable to a plastic repair of the left kidney.

Any surgeon who operates much learns that rules are controversial and not to be followed blindly, but he who reasons out his treatment of hydronephrosis in line with these arguments will prove his surgical judgment by better end results.

The decision for nephrectomy or plastic repair with unilateral hydronephrosis and for repair of the right or left side first with bilateral hydronephrosis does not end the play of surgical judgment (except with nephrectomy). The classification given in Table I of the repair methods in use with insular hydro-

TABLE I. CLASSIFICATION OF PLASTIC REPAIR OPERATIONS OF HYDRONEPHROSIS

I. Pelvioureterolysis
   A. Simple pelvioureterolysis, with
      1. Retrograde dilatation
      2. Division of aberrant vessel
      3. Partial pelvectomy or pelvic plication
         (a) Kelly and Burnam
         (b) Young

II. Incision of the stenosis (when the obstruction has not been removed by pelvioureterolysis, as above)
   A. Simple longitudinal incision, with
      1. Closure after method of Heineke-Mikulicz pyloroplasty (Fenger)
      2. Double incision and closure of each after method of Heineke-Mikulicz (Gibson)
      3. Closure after method of Finney pyloroplasty
      4. Closure after method of Trendelenburg pyloroplasty
         (a) Von Lichtenberg
         (b) Priestley
      5. Closure with fat pad without suture (McIver)
      6. The incision left open and allowed to heal over a splint
      7. Combination of one of above and plication or partial pelvectomy (Young)
   B. Y incision, with
      1. Oblique closure after method of Durante pyloroplasty (Schwyzer)
      2. Long ureteropelvic anastomosis ("the inverted Y," Foley)
   C. W incision (Ballenger—McDonald)
   D. Longitudinal parallel incisions of the ureteral wall down to the mucosa at the site of the stenosis without suturing (Rammstedt)

III. Reimplantation of the ureter into the pelvis (when the insertion is high or when it seems wise to preserve the blood supply of the aberrant vessel)
   A. After complete separation
      1. Oblique anastomosis (Küster)
      2. Split anastomosis (Lubash)
      3. Direct anastomosis
      4. Pelvic anastomosis (Patch and Codnere)
      5. Combination of one of above with plication or partial pelvectomy (Priestley, Sargent)
   B. Lateral (side-to-side) ureteropelvic anastomosis (Priestley) without separation

IV. Combination of one or more above methods, with
   A. Splint
   B. Nephrostomy (or pyelostomy)
   C. Nephropexy
   D. Denervation

nephrosis shows the very wide freedom of choice. No one of these methods can always be used to the best interest of the patient and any surgeon so limited by prejudice or preference shows poor judgment. Some conditions no doubt can be treated as well by any one of several different methods and a fixed preference for any particular one is then legitimate but other conditions might better be treated by other than any of these, therefore it is well to be familiar with all of the different methods.

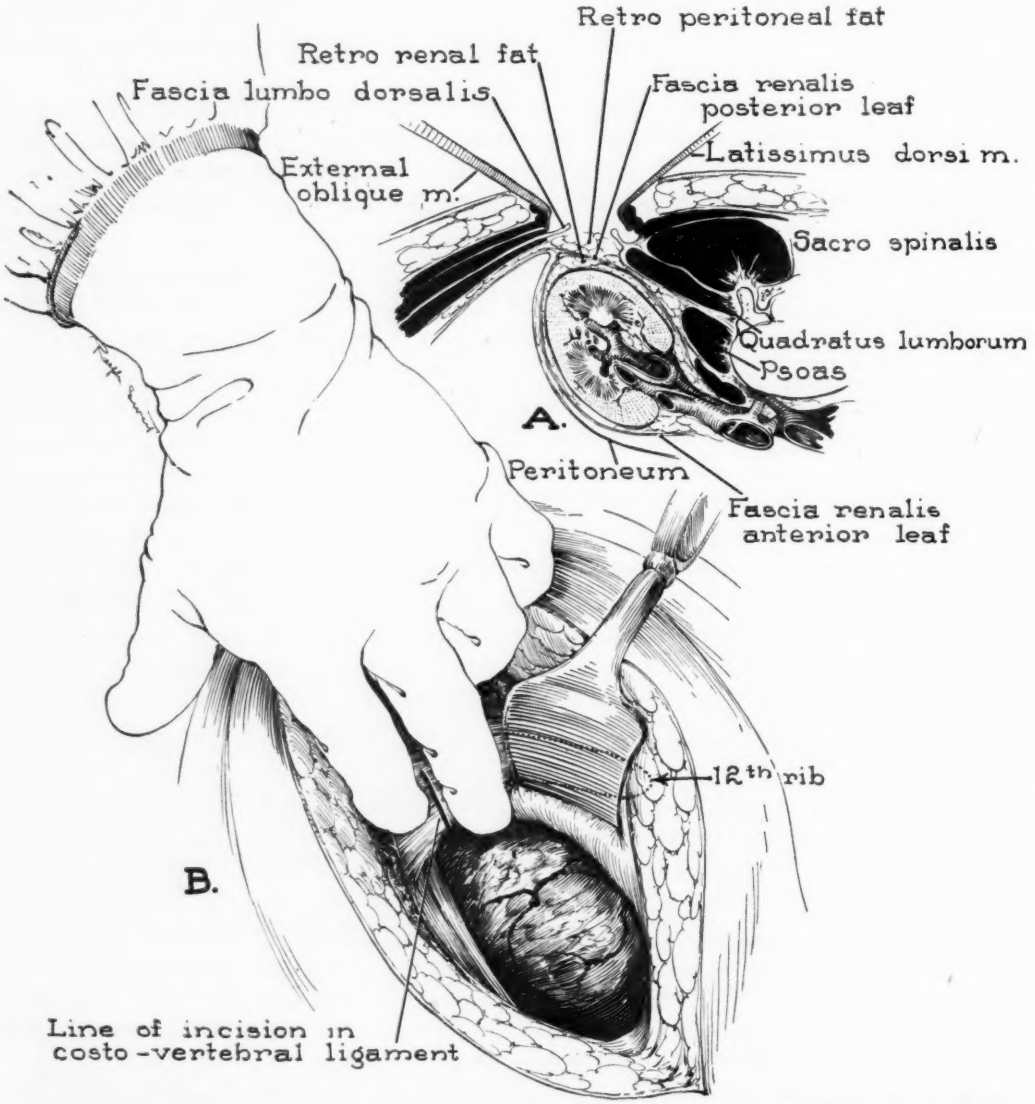


Fig. 1.—Exposure of the hydronephrotic kidney by an incision parallel to the twelfth rib. *A*. The kidney freed first posteriorly along the line of cleavage between retroperitoneal fat and lumbar muscles (quadratus lumborum and psoas). *B*. Division of the costovertebral ligament, care being taken that the pleura has been safely reflected back first, allowing the rib to be lifted (usually a snap is heard), giving adequate exposure.*

*All of the illustrations with the exceptions of Figures 22 and 23 have been drawn by Mr. Ralph Sweet and mostly on lines appearing in the literature, modified as he has seen fit. Failure of acknowledgment of this free use of all papers to include other methods and references on this subject is not intentional.

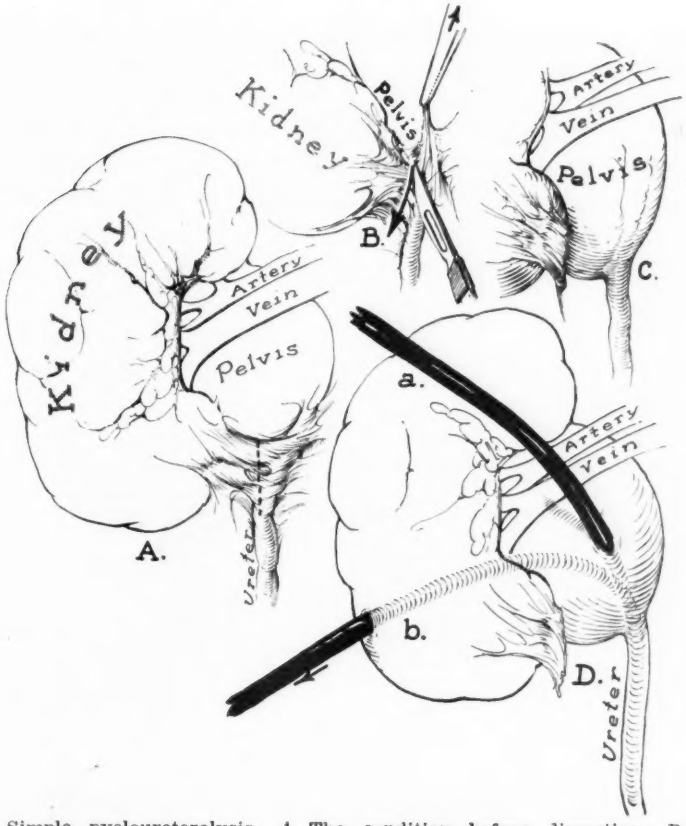


Fig. 2.—Simple pyeloureterolysis. *A*. The condition before dissection. *B*. Removal of bands and adhesions. *C*. The obstruction removed satisfactorily. *D*. Two types of ureteral splint; *a*, through the pelvis (used sometimes without nephrostomy or pyelostomy); *b*, through the kidney (always used with nephrostomy drainage).

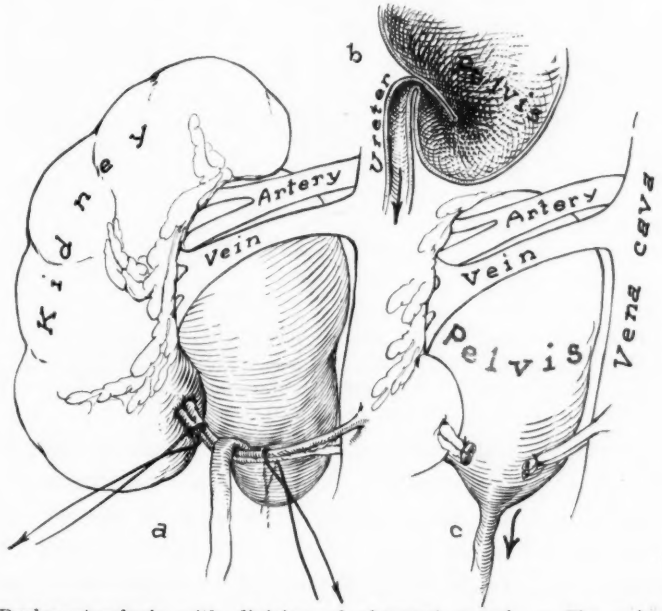


Fig. 3.—Pyeloureterolysis with division of aberrant vessel. *a*. The urinary obstruction of ureteral kink, *b*, caused by the vessel. *c*. The obstruction removed after the ureter has been straightened by division of the vessel.

More than twenty-five surgeons have proposed a method of ureteropyeloplasty or some modification of one. In analyzing this rather large number of presumably different procedures, they can be readily grouped into three distinct types (Table I). First is the simple pyeloureterolysis in which the kidney, pelvis, and upper ureter are freed of adhesions, bands, aberrant vessels, and other obstructive factors. This is followed only by replacing the kidney in a

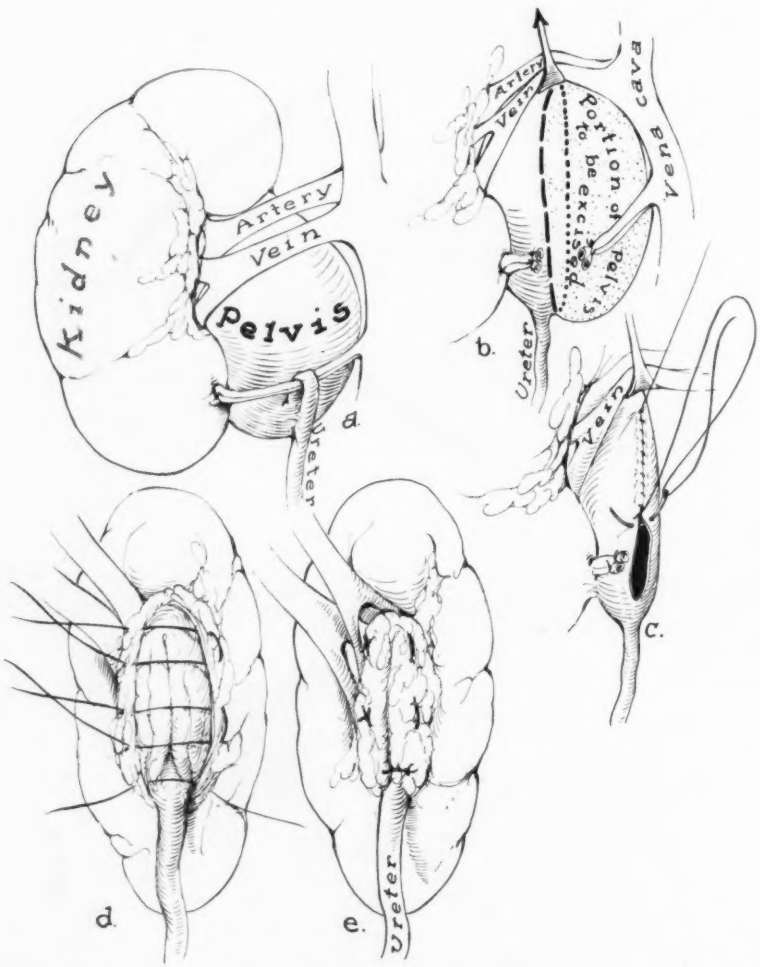


Fig. 4.—Illustration of the use of partial pelvectomy and pelvic plication. *a*. Aberrant vessel kinking ureter as the pelvis distends. *b*. Vessel divided, the portion of the pelvis to be excised indicated by broken line. *c*. Closure after excision leaving almost normal-sized pelvis. *d*. Lembert sutures plicating the walls of the pelvis, *e*, and reducing its size to near normal.

comfortable position, usually with some form of fixation. Second, when the ureteropelvic stenosis or obstruction has not been satisfactorily removed by this simple procedure, then many forms of incision of the area of obstruction have been proposed and all of these may be grouped into types of incision and closure of the stenosis. Third, when, after pyeloureterolysis, it would seem that some type of incision would not satisfactorily remove the obstruction, usually

because of the high insertion of the ureter in the dilated pelvis or because it would seem wise not to divide the aberrant vessel because of the danger therewith of losing too much blood supply, then several methods of reimplantation of the ureter into a different part of the pelvis have been proposed. Any one of these three groups are sometimes combined with the ureteral splint, with nephrostomy or pyelostomy drainage, with intentional nephropexy and occasionally with denervation of the renal pedicle. It is seen that the surgeon is presented with a problem in the cure of hydronephrosis of ureteropelvic origin that can be solved

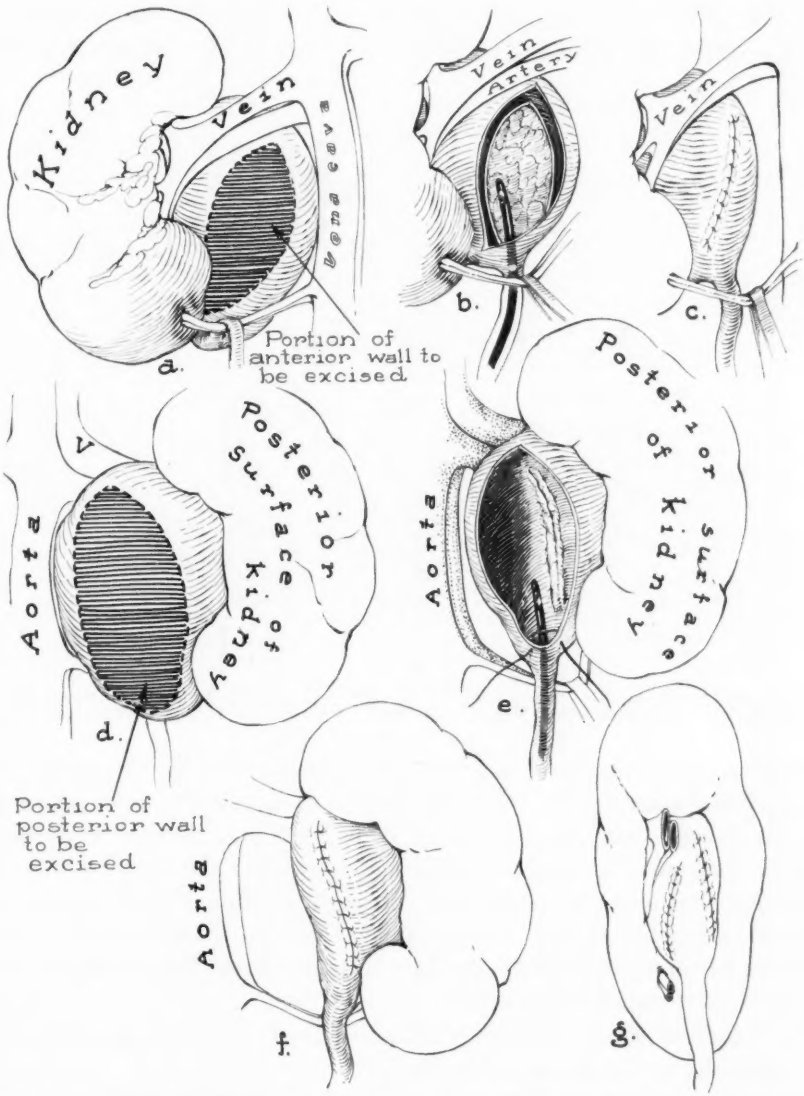


**Fig. 5.**—A method of partial pelvectomy after pyeloureterolysis. *a.* Oblong area to be excised anteriorly; *b.* corresponding oblong area posteriorly (seen through anterior opening) to be excised; *c.* appearance after anterior closure; *d, e,* and *f,* closure of the posterior wound; *g.* pelvis reduced to almost normal size with good ureteropelvic outlet.

satisfactorily only after the kidney and ureter have been well exposed and the situation carefully studied.

In exposing the kidney it is important that the line of cleavage be back of the retrorenal fat, leaving the quadratus lumborum and psoas muscles cleanly uncovered. The posterior surface of the kidney, cleaned down to its capsule, adheres firmly to these muscles later (Fig. 1).

After exposure of the kidney and ureter as just outlined, a complex arrangement of veins and arteries in a mass of fat and fascia is usually found (Fig. 2, *A*). This arrangement must be studied and carefully dissected out (Fig. 2, *B*) so as thoroughly to free the ureteropelvic juncture (shown in Fig. 2, *C*). During this procedure one must decide for or against the preservation of any aberrant arteries; the veins are more or less unimportant. When it would seem

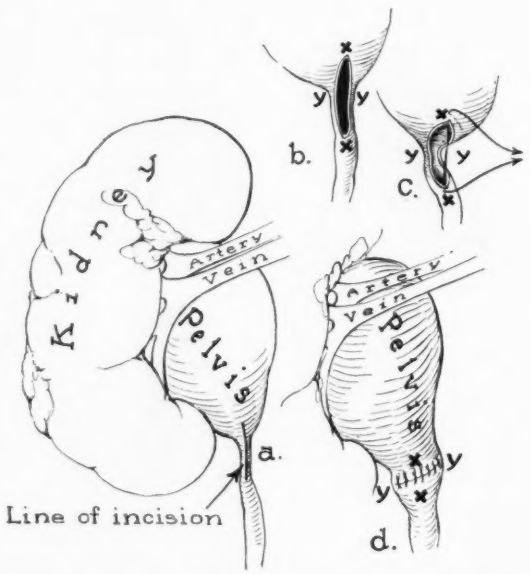


Fig. 6.—Simple incision with closure after the method of pyloroplasty of Heineke-Mikulicz (Fenger). *a*. Line of incision; *b* and *c*, method of closure, *x* to *x*; *d*. dilatation secured.

safe, division of the artery or arteries and pyeloureterolysis frequently removes the obstruction satisfactorily and the kidney then can be replaced in its new bed on the muscles and fixed there by some form of nephropexy if this would seem to be desirable. Usually it is advisable to splint the ureter either through the pelvis (pyelostomy) or, preferably, through the kidney itself with a nephrostomy tube (as shown in Fig. 2, *D*, *a*, pyelostomy, *b*, nephrostomy). As a rule these tubes will hold the kidney in place until anchored by adhesions, obviating the need of intentional nephropexy.

The complete relief sometimes afforded by division of an aberrant vessel which kinks the ureter is shown in Fig. 3.

It sometimes happens that even after complete pyeloureterolysis and division of the aberrant vessel there remains an unusual degree of pyelectasis which if untreated might harbor residual urine and prevent a cure even with a good

ureteropelvic opening. Such a condition is treated by partial pelvectomy (Fig. 4, *a*, *b*, and *c*) or simply by pelvic plication (Fig. 4, *d* and *e*). A modification of partial pelvectomy is shown in Fig. 5 where an elliptical piece of the redundant pelvis is removed from both the anterior and posterior surfaces, reducing the pelvis to a normal size (shown in Fig. 5, *a*, *b*, *d*, and *e*), after closure of each of these (as shown in Fig. 5, *c*, *f*, and *g*).

When it is found after complete pyeloureterolysis and examination through an opened pelvis that the stenosis persists, then it is necessary to remove this obstruction, whether intrinsic or extrinsic, by some plastic procedure. The simplest one first proposed was to incise it longitudinally and close the incision after the method of a Heineke-Mikulicz pyloroplasty as shown in Fig. 6, *a*, *b*, *c*,

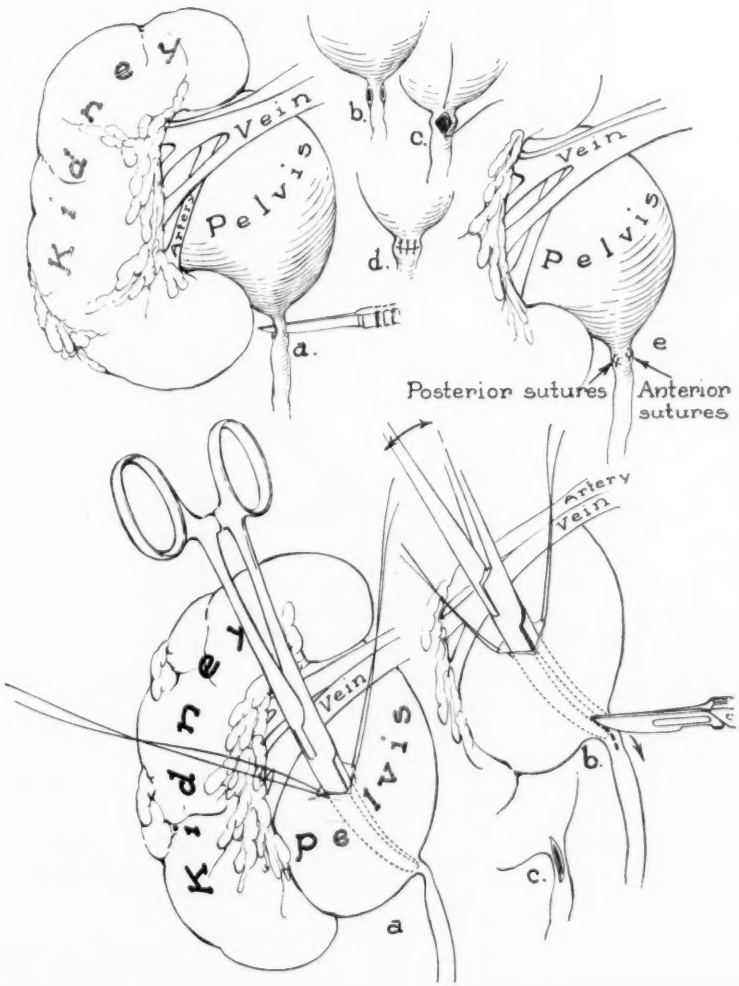


Fig. 7.—The longitudinal incision with closure after the method of Heineke-Mikulicz. The lower diagrams illustrate, *a*, the insertion of the tip of curved clamp through an opening in the pelvis into the area of constriction; *b*, the incision made upon the tip of this clamp as a guide; and *c*, the incision before closure. The upper diagram illustrates how a double incision, *a* and *b*, with closure, *c* and *d*, will secure additional dilatation, *e* (Gibson).

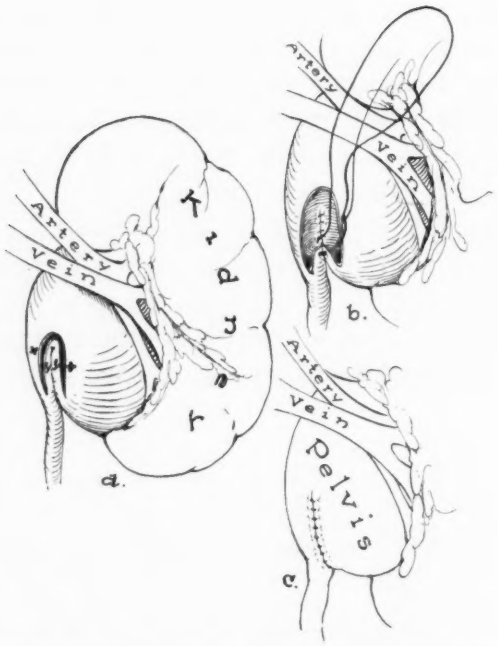


Fig. 8.—The curved incision with closure after the method of pyloroplasty of J. M. T. Finney. *a*. The incision showing how its edges are to be sutured together, *y* to *y* and *x* to *x*; *b*. the inside edges of ureter and pelvis being united; *c*. the outside edges closed.

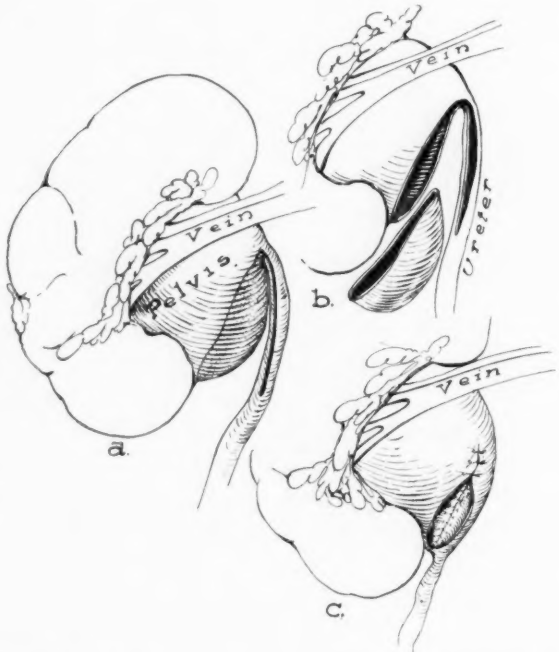


Fig. 9.—Ureteral incision and partial resection of the pelvis with anastomosis after the method of pyloroplasty of Trendelenburg (Von Lichtenberg, Priestley). *a*. The line of resection and incision; *b*. the opening afterward; *c*. the unobstructed orifice secured by closure of the two sides.

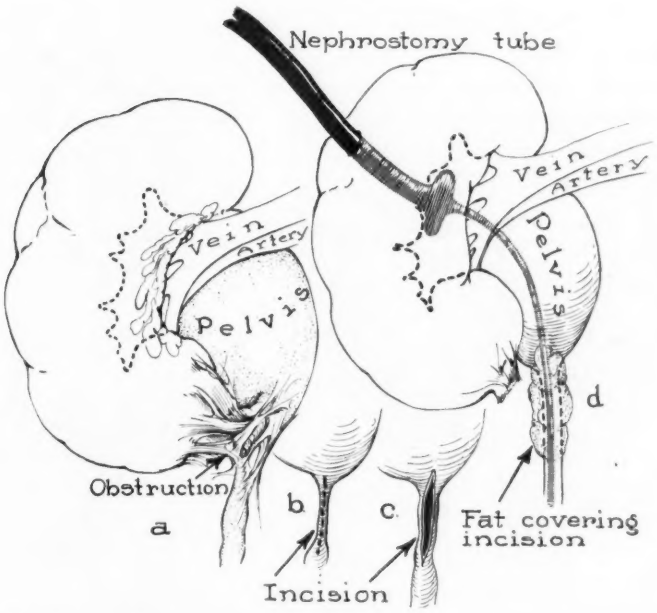


Fig. 10.—Simple incision with closure except for a covering of fat (McIver). *a.* The condition before the ureter and pelvis have been freed; *b.* the long line of incision of the constricted area; *c.* relief of the obstruction by gaping of the wound; *d.* the gaping wound covered by a pad of fat and the ureter splinted with the nephrostomy tube—ureteral catheter combination.

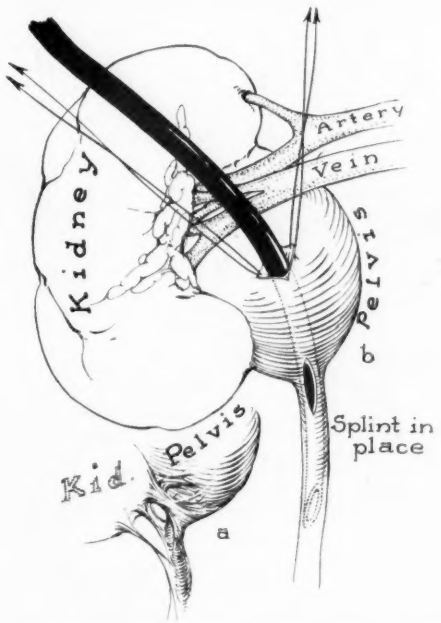


Fig. 11.—Simple incision of the area causing obstruction without closure. *a.* The mass of fibrous bands, adhesions, and vessels before pyeloureterolysis. *b.* Simple incision widening the obstructive area which is then kept dilated until healing has occurred by a splint here shown inserted through a pyelotomy.

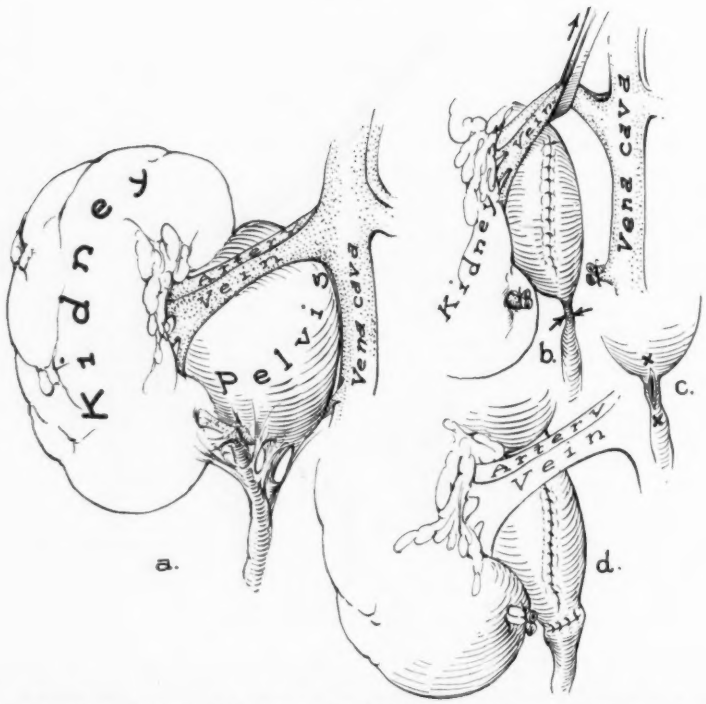


Fig. 12.—Simple longitudinal incision with division of aberrant vessel and partial pelvectomy (Young). *a.* The condition before pyeloureterolysis. *b.* The ureter and pelvis freed and the aberrant vessels divided. The closed incision after partial pelvectomy is shown. *c.* The longitudinal incision of the strictured area. *d.* The ends of the incision (*x* in *c* above) brought together and the ureteral and pelvic walls thus apposed closed by interrupted sutures.

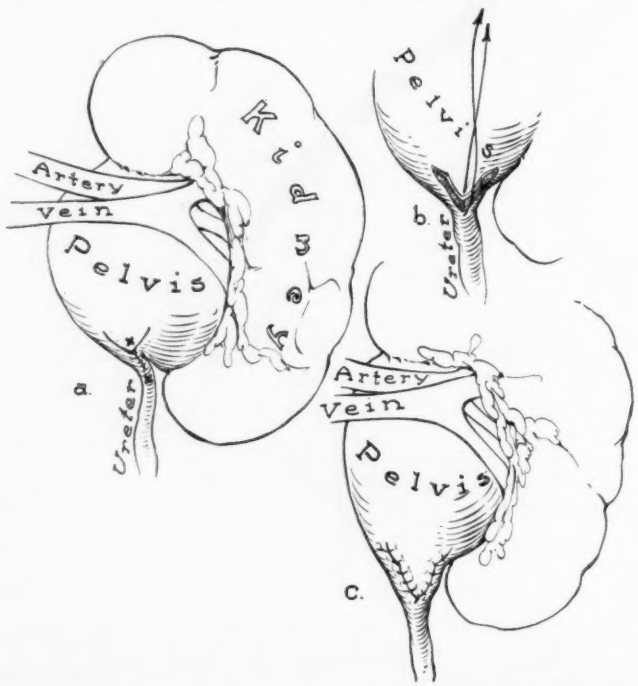


Fig. 13.—The method of a Y-shaped incision at the site of ureteropelvic stenosis (Schwyzer). *a.* The incision, *(x)* marking its fork and tip, respectively. *b.* Method of removing the constriction by bringing the fork and tip together. *c.* Satisfactory relief of the stenosis after suturing.

and *d*. The effect of this can be added to, if necessary, by double incisions and bilateral closure as shown in Fig. 7, *a*, *b*, *c*, *d*, and *e*. These incisions are best made on a clamp inserted through an incision of the pelvis (illustrated in the lower portion of Fig. 7, *a*, *b*, and *c*). A much wider orifice may be secured by applying the principle of Finney's pyloroplasty, a curved incision with bilateral closure, as shown in Fig. 8, or this procedure may be extended so that the balloon

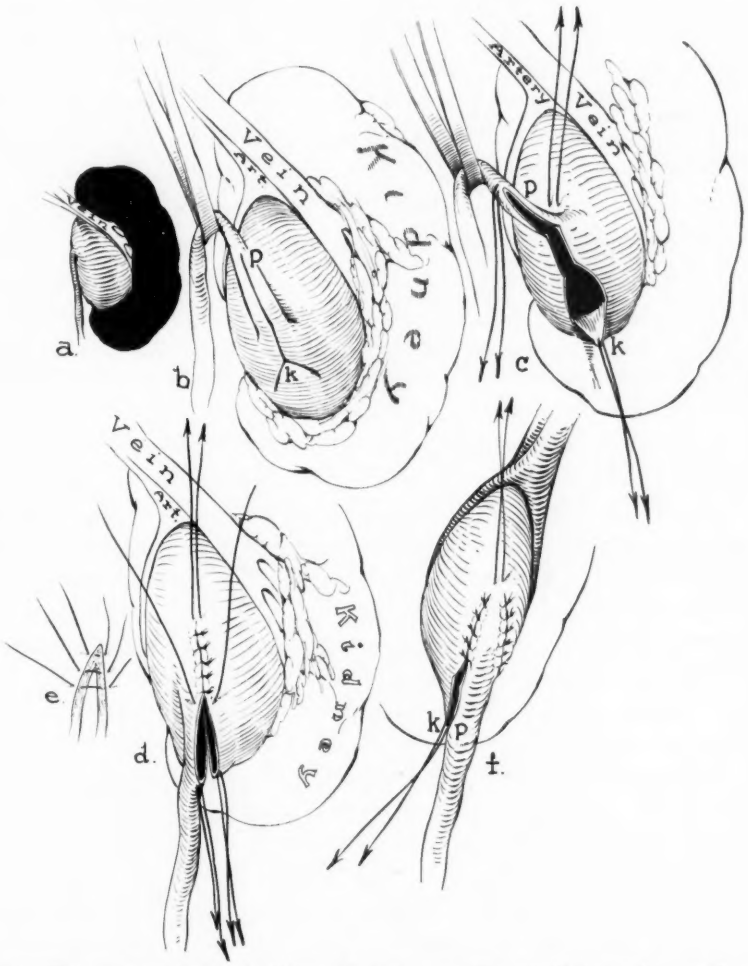


Fig. 14.—The "inverted Y" incision (Foley). *a*. The condition after pyeloureterolysis. *b*. The inverted appearance of the incision with the ureter held up by a tape. *c*. The fork (*k*) brought down to the tip (*p*) of the Y-shaped incision. *d*. Each side of the newly aligned ureteral and pelvic walls united by interrupted sutures. *e*. These sutures preferably do not penetrate the mocosa. *f*. Suturing almost completed, showing the marked widening of the ureteropelvic orifice secured by the procedure.

in the dependent portion of the pelvis is resected, a modification of the Trendelenburg pyloroplasty, as shown in Fig. 9. To get back to simpler methods of enlarging the obstructed area, it has been cut longitudinally, a splint placed down the ureter, and the gaping incision merely covered with a fat pad without closure, as shown in Fig. 10, or it has been incised, splinted as described and then left open to heal, as shown in Fig. 11. Any of the foregoing methods of incision

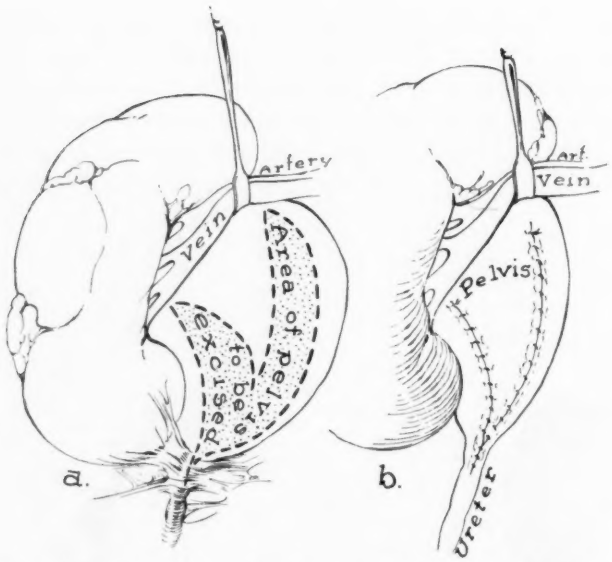


Fig. 15.—The W incision (Ballenger and McDonald). *a.* Shaded area marking the portion of the pelvis to be removed by the W-like incision. *b.* The result after closure by interrupted sutures.

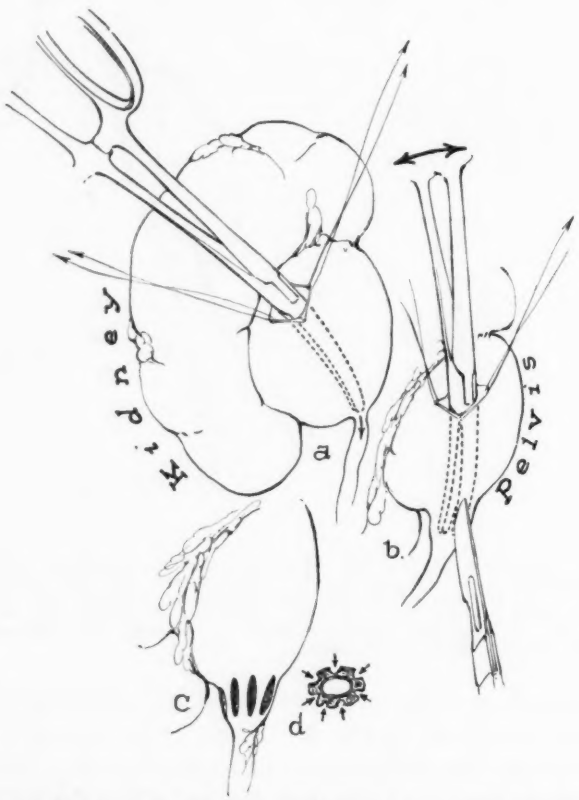


Fig. 16.—Multiple longitudinal incisions (Rammstedt). *a.* The tip of a curved clamp is passed through an opening of the pelvis into the stenosed area. *b.* Multiple longitudinal incisions of the serosa and muscularis, care being taken not to penetrate or injure the mucosa. *c* and *d.* The intact mucosa readily stretched to widen the lumen.

of the area of the stenosis sometimes have been combined with methods of plication or partial pelvectomy (Fig. 12), as has already been described and illustrated for the Trendelenburg procedure illustrated in Fig. 9.

Another very satisfactory way of widening the ureteropelvic orifice is closure of it after Y incision, as shown in Fig. 13, or better still as modified into a long inverted Y, as shown in Fig. 14. With a rather redundant pelvis without much stenosis remaining after pyeloureterolysis, a double-armed incision somewhat in the shape of a W, as shown in Fig. 15, has been proposed. Sometimes more satisfactory because so much simpler than any of these are multiple longitudinal incisions of the muscular layers at the site of the stenosis without penetration of the mucosa, as shown in Figure 16. Without suturing, these parallel cuts of the muscular coats act like pleats and thus produce a satisfactory enlargement of some stenosed areas.

When these two groups of procedures, simple pyeloureterolysis or this in combination with some form of incision and closure, fail to remedy the obstructive condition either because of the unusually high insertion of the ureter into the dilated pelvis or because the aberrant vessel is of such a size that it should be preserved, then several different methods of reimplantation of the ureter into a favorable site of the pelvis have been proposed, as illustrated in Fig. 17. The ureter can even be anastomosed laterally as shown in Fig. 18 without separation from the pelvis and any of the methods of reimplantation may be combined with plication or partial pelvectomy, as shown in Fig. 19.

After the ureteropelvic obstruction has been removed by some one or more of the foregoing procedures, there arises the important problem of splinting the repaired area and of drainage, both intra- and extrarenal. There is some difference of opinion as to the advantage of a pyeloureteral splint, some advocating that it may lead to infection in a kidney which has heretofore been uninfected and for this reason is better omitted. Others believe that even in a clean case the ureter which has been satisfactorily enlarged and straightened, unless kept aligned in its new bed for a required period, may develop secondary adhesions which later on produce kinks and obstructions. As a rule, after a successful ureteroplasty the splint need not be left for any prolonged period, usually from seven to twelve days, and with the more efficient urinary antiseptics available the danger of any troublesome infection is negligible.

Many types of splints have been introduced. Those attached as an extension of a nephrostomy tube (Fig. 20) have no particular advantage but do have the disadvantage that one cannot be removed without the other. Occasions arise when it is advisable to remove the nephrostomy tube or the splint first and leave the other for a time. Experience favors placing the ureteropelvic splint down the ureter and not retrograde (through the bladder). Ureteral catheters retained through the urethra and neck of the bladder occasion discomfort or give rise to infection which often complicate the postoperative care. Ureteral catheterization may become necessary, however, following the removal of the direct splint. With a dilated ureter the No. 10 or 12 French urethral catheter, the closed tip of which has been cut off to leave an end

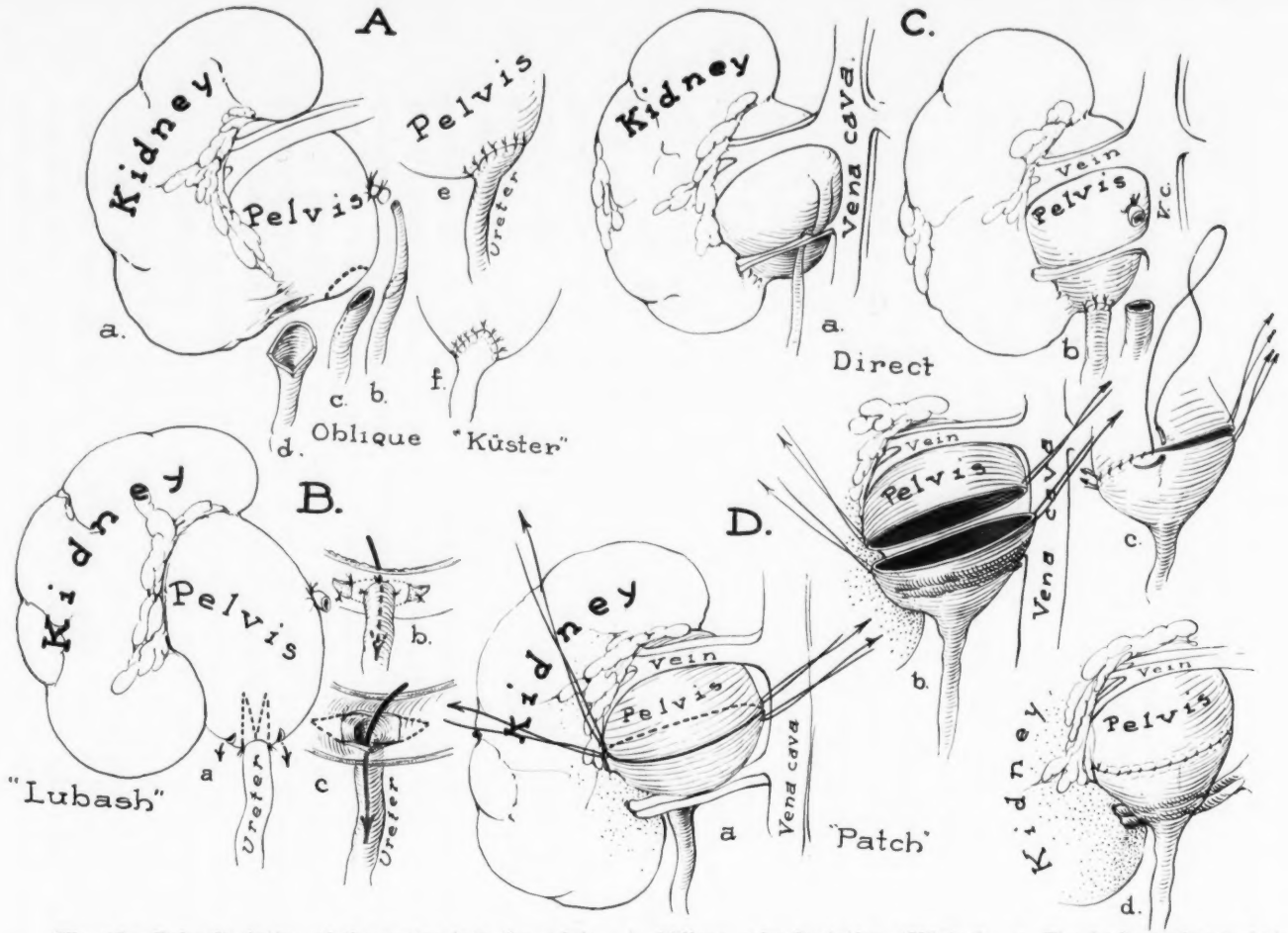


Fig. 17.—Reimplantation of the ureter into the pelvis. *A*. Oblique reimplantation (Küster). *a*. The hydronephrotic kidney with the ureter ligated and divided at its site of high insertion and the favorable position for reinsertion indicated by curved dotted line. *b*. The constricted redundant portion of the ureter removed by oblique division, indicated by the oblong opening. *c*. The open end can be enlarged if necessary by slitting it. *d*. The widely open end thus secured. *e* and *f*. The ureter anastomosed to the pelvis by interrupted sutures.

*B*. Split anastomosis (Lubash). *a*. The end of the ureter split; arrows indicate the two pelvic incisions to each side of the incision at the favorable site for implantation and through which the split ends are to be drawn back, thus anchoring the implanted ureter. *b*. Each of the split ends drawn back through its related incision and sutured on the outside. The ureteral serosa anastomosed to the pelvic wall by interrupted sutures. *c*. The newly constructed ureteropelvic orifice viewed from the inside.

*C*. Direct anastomosis. *a*. The highly inserted ureter kinked over an aberrant vessel. *b*. Directly anastomosed after separation from the pelvis at favorable site by interrupted sutures.

*D*. Pelvic anastomosis (Patch and Codnere). *a*. The whole pelvis divided by circular incision. *b*. The distal end brought under and up in front of the aberrant vessel. *c* and *d*. The pelvis reanastomosed by continuous suture.

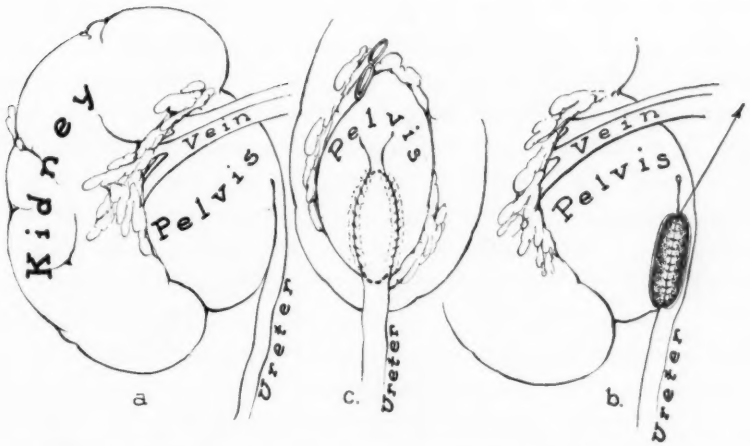


Fig. 18.—Lateral ureteropelvic anastomosis (Priestley). *a.* The ureter lies against the pelvis below the point of constriction. *b.* Longitudinal incisions of the pelvis and ureter. *c.* The pelvis and ureter anastomosed by interrupted or continuous suture.

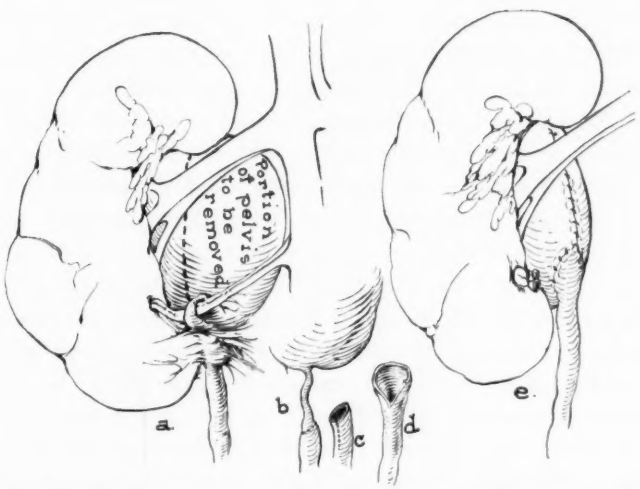


Fig. 19.—Ureteropelvic reimplantation with partial pelvectomy. *a.* Showing the condition with aberrant vessel, ureteral kink, bands and adhesions, and the dilated pelvis, the line for incision to remove part of which indicated by dotted line. *b.* After pyeloureterolysis. *c.* Ureter slit. *d.* The enlarged opening. *e.* Reanastomosis after partial pelvectomy.

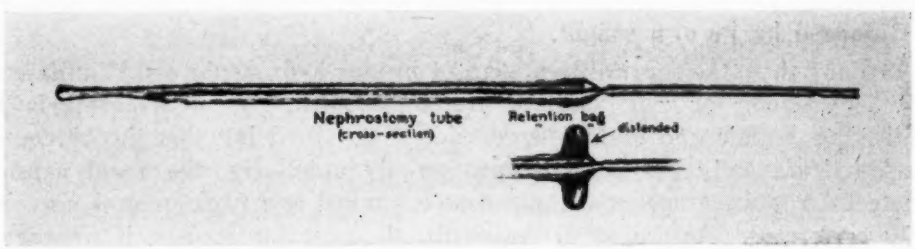


Fig. 20.—The combined nephrostomy tube and ureteral splint (McIver).

opening, will make a good splint. With a normal-sized ureter a ureteral catheter of not too large a size will prove satisfactory. In practically all of these cases direct drainage of the pelvis through the renal parenchyma is preferable to drainage through an opening of the pelvis. The pyelostomy tubes are likely to kink, cannot be replaced, and sometimes tend to dislodge the kidney from its direct contact with the muscles so that it does not become firmly adherent. On the other hand, a nephrostomy tube when properly placed can be removed and replaced at will. Furthermore, pyeloscopy through the opening is possible so that the repaired area can be dilated. The splint should be irrigated. A continuous drip irrigation with Suby's solution "G" or some similar antiseptic will largely obviate any of the risks of a complicating infection. Since irrigation is advantageous, the splint can be placed through the lumen of the nephrostomy tube, which is preferably of large caliber, perforating it at or near the lumbar skin surface, thus avoiding troublesome leakage (Fig. 21).

There are many points in the placement of a nephrostomy tube which are important and which cannot be taken up in detail here. The opening into the pelvis should be made at a thin portion so that the least amount of parenchyma is damaged. It should be made retrograde and the tube later drawn through directly (Fig. 21). It should be made at that portion of the kidney which will permit the tube to run in a straight course through the lumbar incision so that it will not pull the kidney away from its muscular contact nor be kinked when the kidney is replaced and, in addition, so that it can be removed and replaced at will. The bulb catheter has been largely used by others for nephrostomy drainage but it is excelled for this purpose by the cystotomy tube which has the direct open end and the right angle curve to fit the patient's side. The length of the arm of the tube should be chosen to best make this fit. There seems to be no particular difference in the time of renal closure after removal of the large tube as compared with that of a smaller bulb catheter. The nephrostomy tube without a bulb must be anchored to the kidney and to the lumbar wound by suture. A properly placed nephrostomy tube helps to pull the kidney into apposition with the exposed lumbar muscles and keeps it there until adherent so that intentional forms of nephropexy are unnecessary. Whether or not the pelvis has been closed tightly, retrorenal drains are always indicated. It is important that these drains be brought out the lumbar incision at its most dorsal position and away from the nephrostomy tube, not alongside it.

As a postoperative precaution, the patient should be kept on his back or permitted to lie only on the side operated upon so that the kidney will not be dislodged by its own weight.

Briefly then, the surgical treatment of insular hydronephrosis, if unilateral is a nephrectomy or some form of ureteropyeloplasty, if bilateral the latter for both as a rule and of the poorer side first. In doing this the kidney is freed, extrafascially posteriorly; intrafascially anteriorly, the renal capsule is intact. The ureteropelvic arrangement is studied and pyeloureterolysis carefully performed. According to the result, the operator chooses, if necessary, one or more of the three types of procedures classified in Table I under I,

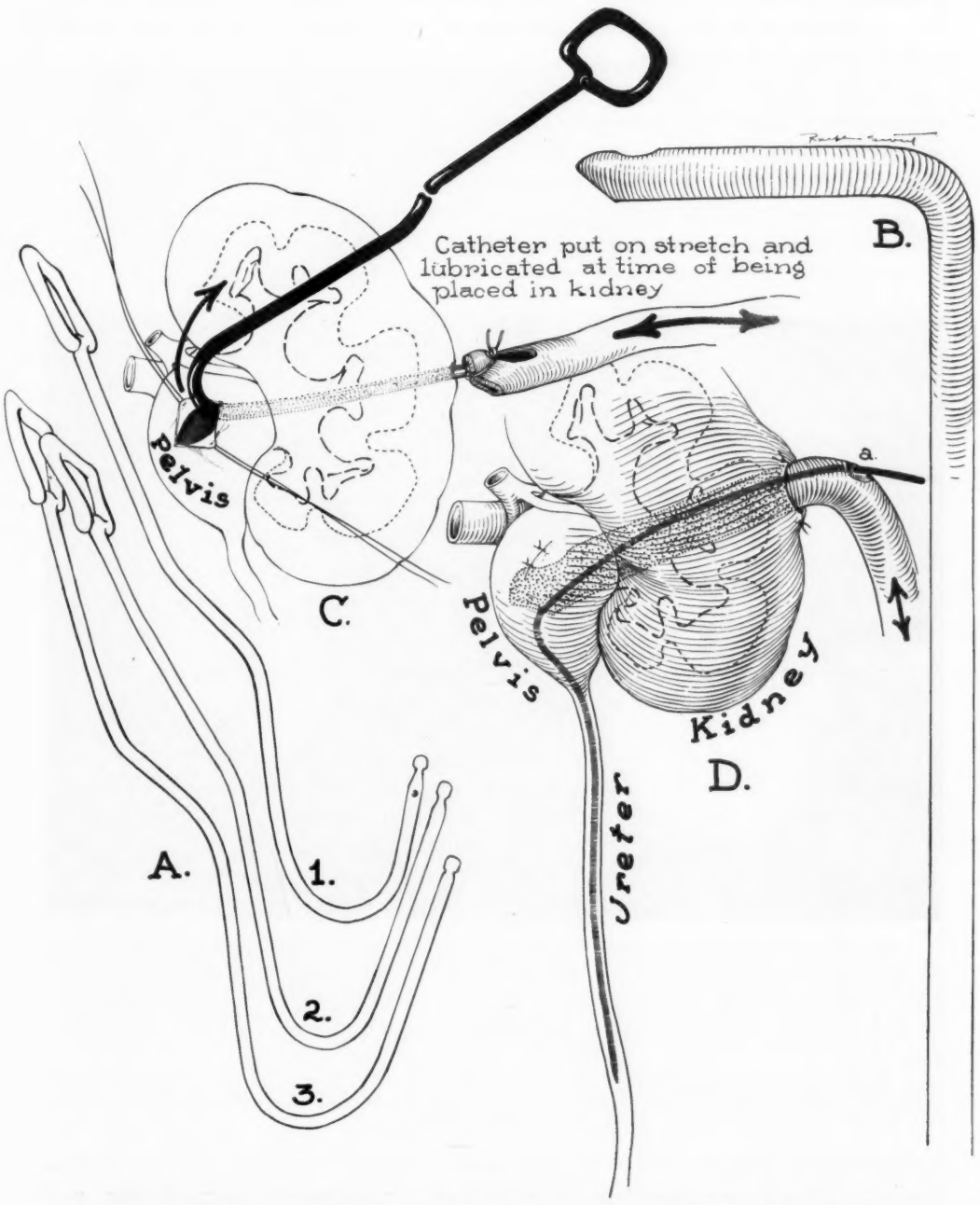


Fig. 21.—The nephrostomy tube and ureteral splint. *A*. The metal guides of various sizes and shapes (*1*, *2*, and *3*), the one which is most suitable being selected. *B*. The nephrostomy tube (angulated suprapubic drain). *C*. The metal guide inserted retrograde through an opening in the pelvis with the tube (suprapubic drain) tied to its end by heavy silk suture. *D*. Tube and splint in place. (The metal guide pulls the tip of the tube to the pelvic opening. The heavy silk tie is cut. The catheter-splint is passed down the tube through a slit in it at *a* and then threaded on down the ureter through the opening of the pelvis which is then closed, as shown here by two interrupted sutures.)

Pyeloureterolysis, II, Incision of the stenosis, III, Ureteral reimplantation, and IV, in combination or not with nephrostomy (pyelostomy), a ureteral splint, and intentional nephropexy.

In the treatment of hydronephrosis caused by an obstruction below the ureteropelvic junction (ureteral—vesical—urethral), the removal of the obstruction (stone, stricture, prostatism, posterior urethral valves, etc.) comes first. In most cases this will be enough but secondary changes of back pressure in the bladder and the ureter may have been produced along with the hydronephrosis and these changes occasionally are of such a nature as to be obstructive. The commonest secondary conditions of this type are vesical diverticulum,

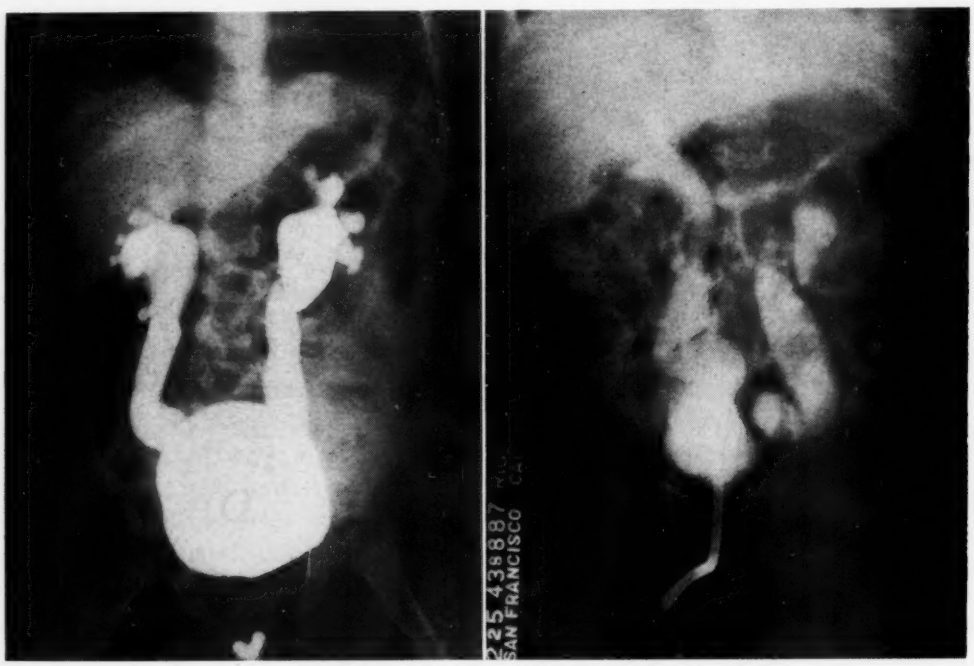


Fig. 22.—Photographs of cystograms in a 4-year-old boy in whom congenital posterior urethral valves had been destroyed two years previously. *a*, With the bladder filled; *b*, after the bladder content had been drained off. The boy is gaining and growing normally. He no longer has attacks of fever but the urine showed microscopically on Sept. 17, 1945: white blood count, loaded; red blood count, ♂; rods ++; albumin +; sugar ♂. Total renal function per catheter on Sept. 18, 1945; appearance time 11 minutes; I, 25 c.c., 13 per cent; II, 30 c.c., 19 per cent; III, 30 c.c., 8 per cent; IV, 50 c.c., 7 per cent; total 47 per cent. Nonprotein nitrogen: 54.5.

Progressive loss of function in the near future could be due to back pressure or infection. The conclusion that it was mostly due to back pressure, in which case renal reserve power should be demonstrable by retention ureteral catheter, would justify an attempt to straighten out the ureters by partial resection and reimplantation.

ureterovesical stenosis, and valve-formation from an elongated tortuous hydroureter. Diverticulectomy, simple meatotomy, or ureteral implantation and complete ureterolysis with partial ureterectomy to straighten the ureter and then reimplantation into the bladder, respectively, for each of these conditions now and then are indicated. The indication for straightening tortuous hydroureters which occur most typically in two conditions is rare. The advanced back pressure changes which follow congenital formation of a valve in the posterior urethra are familiar to all urologists (Fig. 22). Destruction of the

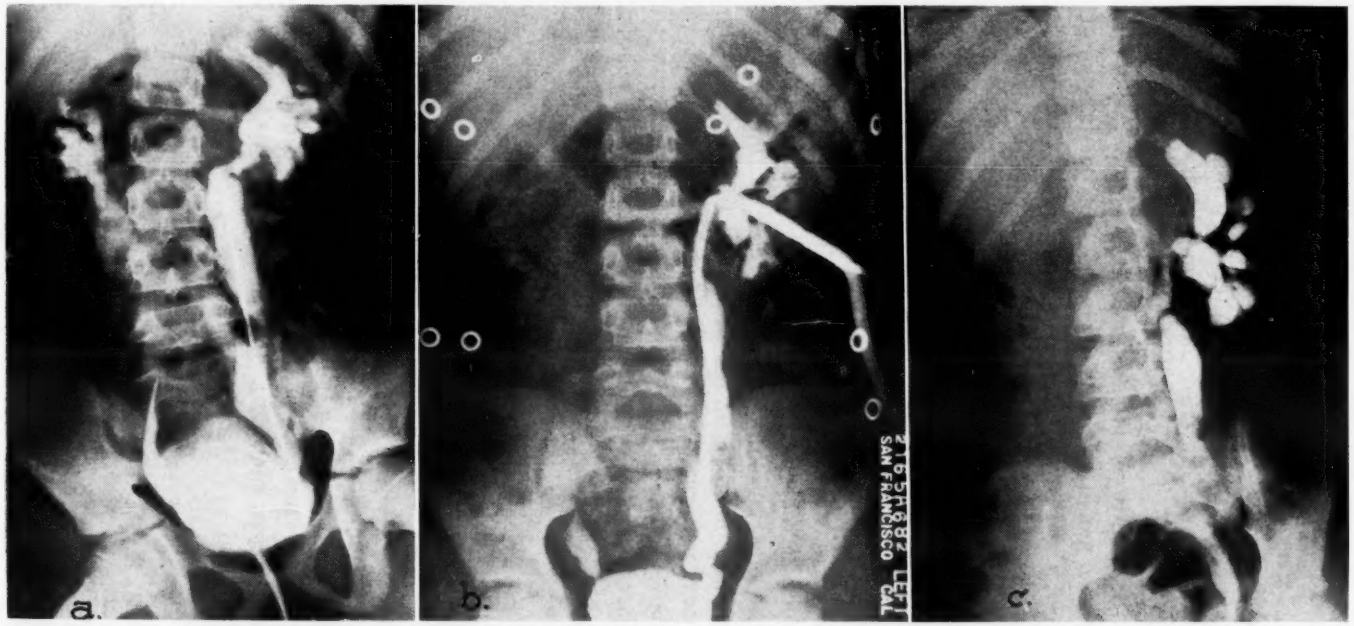


Fig. 23.—Tortuous elongated hydroureters of unknown etiology in a girl 11 years old, with a known pyuria for ten years and a history of frequent attacks of fever. She had been treated with every known urinary antiseptic and for the past twenty months by periodic ureteral catheterization and lavage of the renal pelves with silver nitrate.

During 1944 with many attacks of fever, there was a gradual loss of function (1943, 70 per cent; 1944, 50 per cent; 1945, January 26, 20.5 per cent, January 29, 32.5 per cent). Retrograde ureteropyelograms taken on June 13, 1944, demonstrate the atrophic right kidney, and the elongated tortuous hydroureters. On Jan. 30, 1945, the right kidney, almost functionless from atrophic pyelonephritis and causing the greater pyuria, was removed with as much of the hydroureter as was possible through the lumbar incision. At the same operation the left kidney was exposed and the upper half of the tortuous and kinked ureter was dissected free. A No. 12 French ureteral catheter, cut off obliquely at its tip in order to have the end open, was passed through the right angle nephrostomy tube and halfway down the ureter as a splint to keep it straight, as shown in *b*.

On April 5, 1945, through a midline suprapubic incision, the lower third of the left ureter was freed extraperitoneally and after resection of more than 5 cm. to straighten it, the new end of the ureter was implanted into the bladder by the splint method through the old dilated orifice.

*c*, A nephrostogram showing the postoperative result. Convalescence was uneventful and afebrile. On May 17, 1945, however, the total phthalein was only 25 per cent in two hours and at another check, in September, it had not improved although there have been no more attacks of fever and the child looks well. The poor reserve power of the left kidney is shown by the failure of function to return to normal. The prognosis is not good.

valve removes the primary obstruction but few of these boys live long afterward, most of them dying eventually of renal insufficiency. In female infants and children, similar back pressure changes in the ureters and kidneys are seen without any known or discoverable cause of primary obstruction (Fig. 23). In either of the foregoing cases hydronephrotic kidneys, uninfected or only mildly so, will undergo considerable repair with return of renal sufficiency after nephrostomy or a plastic operation on the ureter by which the elongated tortuous ureter is shortened and straightened out so as not to be obstructive secondarily.

The dilatation in both conditions is mostly ureteral and pelvic, little calyceal. Total renal function sometimes is fairly good, but persistence of infection is the rule in spite of the best known therapy by mouth or by ureteropelvic lavage, and progressive atrophic pyelonephritis leads eventually to death from renal insufficiency. A plastic operation on these hydroureters is indicated only when previous tests not only have demonstrated considerable renal reserve but have given reasonable assurance that urinary infection can be controlled.

## CONCLUSION

The surgical treatment of hydronephrosis varies with the condition. When unilateral of ureteropelvic origin, the choice of treatment is between nephrectomy and a plastic repair of the obstruction. When the relative function of the hydronephrotic side is less than one-fifth of the total, and the opposite kidney is healthy and compensatory, nephrectomy is in order. The repair of those hydronephrotic kidneys more capable than one-fifth of total follows three types of surgical procedures: Pyeloureterolysis may relieve the condition. When this fails to remove the obstruction, the ureteral narrowing may be enlarged by one of various methods of incision and closure, and when this would seem inadequate several methods of reimplantation of the ureter into its pelvis are available.

In bilateral hydronephroses of ureteropelvic origin, only a functionless kidney ever is removed. In bilateral repair, the poorer side should be done first and even when equally hydronephrotic, too long an interval should not elapse before repairing the second side.

In hydronephroses from obstructions below the ureteropelvic juncture (stone, prostate, stricture, etc.), removal of the obstruction usually suffices. Acquired changes of back pressure such as a diverticulum or tortuous ureter, however, may be obstructive and require treatment.

## REFERENCES

Ballenger, E. G., and McDonald, H. P.: Conservation of the Hydronephrotic Kidney, J. Urol. **47**: 203-208, 1942.

Deming, C. L.: Ureteropelvic Obstruction Due to Extrinsic and Intrinsic Lesions of the Ureter as a Clinical Entity and Its Treatment, J. Urol. **50**: 420-431, 1943.

Fenger, C.: Operation for the Relief of Valve-Formation and Stricture of the Ureter in Hydronephrosis and Pyonephrosis, J. A. M. A. **22**: 335-343, 1894.

Idem: The Collected Works of Christian Fenger, Vol. 2, Philadelphia and London, 1912, W. B. Saunders Company, pp. 687-704.

Foley, F. E. B.: A New Plastic Operation for Stricture at the Uretero-pelvic Junction; Report of 20 Operations, J. Urol. **38**: 643-672, 1937.

Gibson, T. E.: Hydronephrosis: Standardization of Surgical Treatment, New England J. Med. **222**: 910-917, 1940.

Hinman, F.: Obstructive Hydro-ureteral Angularity With Hydronephrosis in Children, Arch. Surg. **18**: (Part I) 21-58, 1929.

Idem: The Treatment of Hydronephrosis, Southwestern Med. **26**: 357-368, 1942.

Kelly, H. A., and Burnam, C. F.: Diseases of the Kidneys, Ureters, and Bladder, Vol. 1, chapter 17, New York, 1922, D. Appleton & Co.

Küster, E.: Ein Fall von Resection des Ureter, Arch. f. klin. Chir. **44**: 850-854, 1892.

Lubash, S.: Uretero-pyeloneostomy for Hydronephrosis; a New Operative Technique, J. Urol. **34**: 222-229, 1935.

Lubash, S., and Madrid, A.: Uretero-pyeloneostomy for Hydronephrosis, With Case and Experimental Reports, J. Urol. **38**: 634-642, 1937.

McIver, R. B.: Plastic Surgery of the Renal Pelvis, J. Urol. **42**: 1069-1083, 1939.

Patch, F. S., and Codnere, J. T.: The Treatment of Hydronephrosis Secondary to Aberrant Renal Vessels, Canad. M. A. J. **45**: 495-499, 1941.

Priestley, J. T.: The Conservative Surgical Treatment of Non-calculous Hydronephrosis, Surg., Gynec. & Obst. **68**: 832-841, 1939.

Sargent, J. C.: Basic Principles Governing Conservative Surgery in Hydronephrosis, J. Urol. **47**: 323-343, 1942.

Schwyzer, A.: A New Pyelo-ureteral Plastic for Hydronephrosis, S. Clin. North America **3**: 1441-1448, 1923.

Von Lichtenberg, A.: Plastic Surgery of the Renal Pelvis and Ureter, J. A. M. A. **93**: 1706-1708, 1929.

Young, H. H.: Obstructions to the Ureter Produced by Aberrant Blood Vessels; A Plastic Repair Without Ligation of Vessels or Transplantation of Ureters, Surg., Gynec. & Obst. **54**: 26-38, 1932.

# A METHOD FOR THE CHEMICAL PRODUCTION OF A PROLONGED SYMPATHETIC PARALYSIS

## Report of Its Use in Two Patients With Causalgia

Major Theodore B. Rasmussen and Captain Alfred A. Alessi, Medical Corps, Army of the United States

OUR recent acquisition of a small quantity of a slowly absorbed local anesthetic agent (Rectocaine*) suggested the possibility of increasing the effectiveness of paravertebral injections in the treatment of causalgia by prolonging the resultant sympathetic paralysis. Cases 1 and 2 are reported to indicate the desirability of further investigation of this procedure in various conditions in which temporary sympathetic denervation is indicated.

### CASE REPORTS

Case 1.—A 31-year-old Chinese soldier sustained a perforating bullet wound of the left shoulder on March 13, 1945, which produced a compound fracture of the upper third of the humerus. The patient experienced immediate weakness and numbness of the arm. After a change of cast and manipulation of the fracture on March 23, 1945 (eleven days after injury), he noted the onset of severe constant burning pain in the palm of the hand. He was admitted to this hospital, April 23, 1945, incapacitated by this persistent pain. On hot sunny days the pain was particularly severe, while on cool rainy days there was slight relief. Cold, wet compresses on the hand produced a similar lessening of the pain. He carefully protected the left forearm and hand from contact with other objects. The left hand was pinker, warmer, and drier than the uninvolved hand. The nerve lesion could not be properly evaluated because of the marked aggravation of the pain produced by touching or moving the hand. A diagnosis of moderately severe causalgia of the left arm was made.

A paravertebral injection was done on April 23, 1945 (six weeks after injury), according to the technique described by White and Smithwick.[1] Fifteen cubic centimeters of 2 per cent procaine were injected along the left side of the bodies of the first and second thoracic vertebrae, producing marked vasodilatation of the hand and a typical Horner's syndrome within five minutes. The pain was completely relieved for one hour and then returned essentially unchanged as the procaine effect disappeared. An accurate examination of the peripheral nerves during the period of freedom from the pain revealed a slight median nerve paresis involving both the motor and sensory components. Function of the hand was poor due to periarticular thickening which produced considerable limitation of motion of all the finger joints. Four days later the paravertebral injection was repeated with similar prompt sympathetic paralysis and pain relief. Before the needles were withdrawn, 2½ c.c. of rectocaine were injected into each. The sympathetic paralysis and relief of pain persisted for forty-eight hours, with the latter then returning with slightly lessened severity. Since it was felt that the amount of rectocaine was insufficient, a third injection was done on May 3, 1945 (nine days after the first injection and seven weeks after injury). After 5 c.c. of procaine injected at each segment had again produced prompt sympathetic paralysis and relief of pain, 4 c.c. of rectocaine were introduced into each of the two needles. This time the pain did not return and the relief persisted throughout the follow-up period of ten weeks.

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*Containing 5 per cent benzyl alcohol, propylaminobenzoate, and procaine. From the C. F. Kirk Pharmaceutical and Biological Laboratories, New York, N. Y.

During the third week after this last injection the miosis of the Horner's syndrome gradually disappeared although the narrowing of the palpebral fissure remained marked. After four weeks the skin of the left arm and left side of the face became slightly moist but visible perspiration was still absent. During the seventh week the narrowing of the left palpebral fissure disappeared. Nine weeks after the last injection a partial sudomotor paralysis was still present. Exposure to the tropical sun for a few minutes at this time produced profuse perspiration over the right side of the face, right arm, and upper chest, and in contrast caused only a moist texture of the skin of the corresponding areas of the injected side. The large drops of perspiration covering the right side of the face and the right upper chest wall stopped sharply at the midline. When the patient returned to duty at the end of the tenth week he perspired nearly as copiously on the left side as on the right. Hand function had improved until there was nearly normal mobility of the finger joints. There was still a slight paresis of the median nerve which contributed to his relatively insignificant residual disability.

The sympathetic paralysis of the left side of the face was complete for two weeks, partial during the next seven weeks, and gradually disappeared during the tenth week. The sudomotor paralysis of the arm was essentially complete for four weeks and was then partially present until it also disappeared during the tenth week.

CASE 2.—A 31-year-old Chinese soldier sustained a penetrating gunshot wound of the right arm, March 16, 1945, which resulted in a compound fracture of the middle third of the humerus and a paresis of the median and ulnar nerves. Three days later a hot, throbbing, severe, constant pain appeared throughout the palmar surface of the right hand. This pain persisted unchanged until the patient's admission to this hospital on May 20, 1945. Examination revealed nonunion of the humerus with only slight pain at the fracture site. Moving the arm at this point did not alter the pain in his hand. The patient held the fingers of the right hand in extension and constantly protected the part against movement or contact with other objects. Even light touch on the palm caused marked aggravation of the pain. The pain was worse on hot sunny days and was somewhat relieved by cold wet compresses on the hand. The right hand was pinker and warmer than the left and the skin had a velvety texture to the touch. The vasodilatation was so extreme that moderate pressure with a pin in testing sensation frequently produced tiny drops of blood. The skin was equally moist in the two hands. Since he would permit only a sketchy examination of the hand the detailed delineation of the nerve lesions was postponed. Thus, the picture of a typical moderately severe causalgia was presented.

A paravertebral injection was done on May 25, 1945 (five and one-half weeks after the injury). Two needles were inserted into the back down to the right side of the bodies of the first and second thoracic vertebrae in the manner described by White and Smithwick.[1] The needles were directed slightly more caudally than usual but otherwise the placement appeared to be satisfactory. Five cubic centimeters of 2 per cent procaine were injected into each needle, producing good vasodilatation of the hand and complete relief of pain within five minutes. A few minutes later a typical Horner's syndrome appeared. One ampule (5 c.c.) of rectocaine was then injected into each of the needles. The patient was kept in the left lateral decubitus position for one hour in an effort to prevent too widespread diffusion of the drug. With the relief of pain an accurate examination of the functions of the peripheral nerves was now possible and severe but partial lesions of both the median and ulnar nerves were found to be present.

The complete relief of pain persisted throughout the follow-up period of four months. The miosis and narrowing of the palpebral fissure almost completely disappeared after twenty-four hours, while the anhydrosis of the right half of the face persisted for seven days. The right hand remained dry and warmer than the left with visibly dilated veins for two weeks, at which time the hand became moist and the same temperature as the left one. There was still no visible perspiration, however, although it was profuse on the normal side. Three weeks after the injection the patient perspired equally on the two sides.

In this case the sympathetic denervation of the right side of the face was much more transitory than that of the arm, presumably due to the placement of the needles more caudal to the stellate ganglion than usual. There was a complete sudomotor paralysis of the arm for two weeks with gradual recovery of this function during the third week. Subsequently the median and ulnar nerves were explored and the patient prepared for a bone graft of the humerus.

## DISCUSSION

Paravertebral injection of procaine is being used extensively for the treatment of major and minor causalgia with satisfactory results in many cases, particularly the milder variety. In a series of 100 Chinese patients with causalgia (to be reported later) approximately 10 per cent were completely relieved of all pain either immediately or within four weeks after one, two, or three such injections. In an additional 40 per cent, adequate but not complete relief of pain resulted from repeated paravertebral injections of procaine. In the remaining 50 per cent the relief of pain was inadequate and a surgical attack on the sympathetic nervous system was usually necessary. The prolonged action of rectocaine promises to increase the effectiveness of temporary chemical sympathetic denervation of an extremity and to render a surgical sympathectomy less often necessary in the treatment of causalgia. The rapidity with which crippling trophic changes occur in the presence of persistent causalgia makes the prompt alleviation of the pain particularly important. Since patients not yet ready for a major surgical procedure tolerate paravertebral injections well, anything which will increase their effectiveness in relieving the pain will bear investigating.

This procedure should be of value in other conditions for which sympathetic denervation is indicated, that is, the vasospasm associated with injury or emboli of the great vessels, selected cases of peripheral vascular disease, angina pectoris and painful aortic aneurysms, severe hyperhydrosis, and selected cases of congenital megacolon.

The injection of alcohol to produce prolonged sympathetic paralysis, introduced by Swetlow,[2] has gained favor for certain conditions, but has several disadvantages which are avoided by the use of a nondestructive drug. The severe persistent pleuritic pain and intercostal neuritis occasionally produced by injection of alcohol in the thoracic segments should not occur and did not occur in either of the patients described. The sclerosing effect of the alcohol makes accurate placement of the needles of greater importance than when a nonsclerosing agent is used. After a primary failure, due to the scarring produced, secondary injections of alcohol are seldom successful. Although we have had no opportunity to investigate the point, repeated injection of rectocaine should theoretically continue to be effective.

The principal objection that might be raised to the use of a slowly absorbed agent like this is the fact that some adhesions may be produced around the rami communicantes and sympathetic chain which might make subsequent surgical dissection more difficult. This objection is, of course, present to a still

greater degree with the injection of alcohol. If a major operation can be avoided, the temporary Horner's syndrome is of little importance.

The usual safeguards against intravascular, intrathecal, and intrapleural injection must be rigidly observed. Preoperative medication with a barbiturate lessens the possibility of toxic reactions to the procaine. Injections for sympathetic denervation of the arm should be preceded by hypodermic administration of atropine in order to safeguard against syncope and other vagal reactions. The preliminary injection of 5 c.c. of procaine into each needle is necessary to verify promptly the proper placement of the needles and to prove that sympathetic denervation produces the desired relief of symptoms before the longer acting drug is injected. Also, in cases of an adverse reaction to the procedure, only a short acting drug need be counteracted. If a satisfactory sympathetic paralysis develops within ten minutes after injection of the procaine, one ampule (5 c.c.) of rectocaine should be injected into each needle.

The frequency with which major and minor causalgia is encountered in war wounds of the extremities prompted us to report the results in these first two cases although full evaluation of the procedure, its advantages, its disadvantages, and its possible complications must await further trial.

## CONCLUSIONS

1. Paravertebral injection of a slowly absorbed anesthetic agent produced prompt and complete relief of pain in two patients with causalgia of the arm.

2. A persistent sympathetic paralysis was produced in each instance, gradually disappearing in ten weeks in Case 1 and in three weeks in Case 2.

3. Further trial of this procedure in causalgia and other conditions in which temporary sympathetic denervation is indicated seems to be warranted.

## REFERENCES

1. White, J. C., and Smithwick, R. H.: The Autonomic Nervous System, New York, 1941, The Macmillan Company.
2. Swetlow, G. I.: Paravertebral Alcohol Block in Cardiac Pain, Am. Heart J. 1: 393-412, 1926.

# TENON AND MORTISE GRAFTS FOR BRIDGING METACARPAL DEFECTS DUE TO GUNSHOT WOUNDS

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IN HOSPITALS in the Zone of the Interior, metacarpal fractures sustained in combat by high velocity bullets or shell fragments with loss of substance of a part or all of the metacarpal shaft are frequently seen. Many of these are complicated by extensive wounds of the soft parts, loss of tendon substance, and severance of the digital nerves. Obviously, when considerable damage to the soft tissues, tendons, and nerves exists, extensive surgical procedures to reconstruct these bone defects are not indicated. However, there are a number of cases in which damage to soft tissue is minimal, but the digit is useless because of loss of continuity of the metacarpal shaft, with resultant shortening of the metacarpal; this causes displacement of the joint into the palm, allowing the soft tissues to form a mechanical block. The adjacent interosseus muscles lose ability to flex the proximal joint. The head angulates into the palm causing hyperextension of the metacarpophalangeal joint. The patient objects to the appearance of the depressed knuckle and is justifiably disturbed at the prospect of sacrificing an apparently restorable digit. If other soft tissues and tendons are irreparably damaged, amputation, of course, is the simplest and most expeditious means of treatment. However, as Slocum and Pratt[5] and Bunnell[2] have pointed out, excision of a complete metacarpal, particularly the third and fourth, weakens the grasp considerably because of disruption of the metacarpal arch; frequently the adjacent digits angulate and rotate toward each other with resulting overlapping of the phalanges as the hand is flexed. This often constitutes a major disability.

## OPERATIVE PROCEDURE

Faced with the problem of reconstructing a number of restorable digits, we have utilized an operative technique for which we claim no originality but which has been sufficiently successful to warrant its description. Adherent scars on the dorsum of the hand in the region of the operative site (invariably present in these penetrating wounds) should be excised at a preliminary stage. Usually, simple excision of scar with a small amount of undercutting of the skin and suture will be sufficient to provide an adequate covering. The involved metacarpal is approached through a dorsal incision either lateral or medial to the extensor tendon. The extensor tendon is retracted and the metacarpal shaft fragments are completely freed subperiosteally. The distal and proximal fragments are then resected until a transverse cortical surface can be obtained and the medullary canal reamed out with a drill and small curette for a distance of approximately 1.5 cm. The resulting metacarpal usually consists of only the head and base, occasionally with a very small

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fragment of attached shaft. Traction on the involved digit at this time will demonstrate that the normal length of the metacarpal in most cases will be almost completely restored if too long an interval has not existed since the occurrence of the fracture. A cortical tibial bone graft the width of the normal metacarpal shaft, sufficiently long to bridge the gap completely in the involved shaft and, in addition, to allow a tenon to project approximately 1.5 cm. on the distal and proximal ends, is removed from the medial proximal

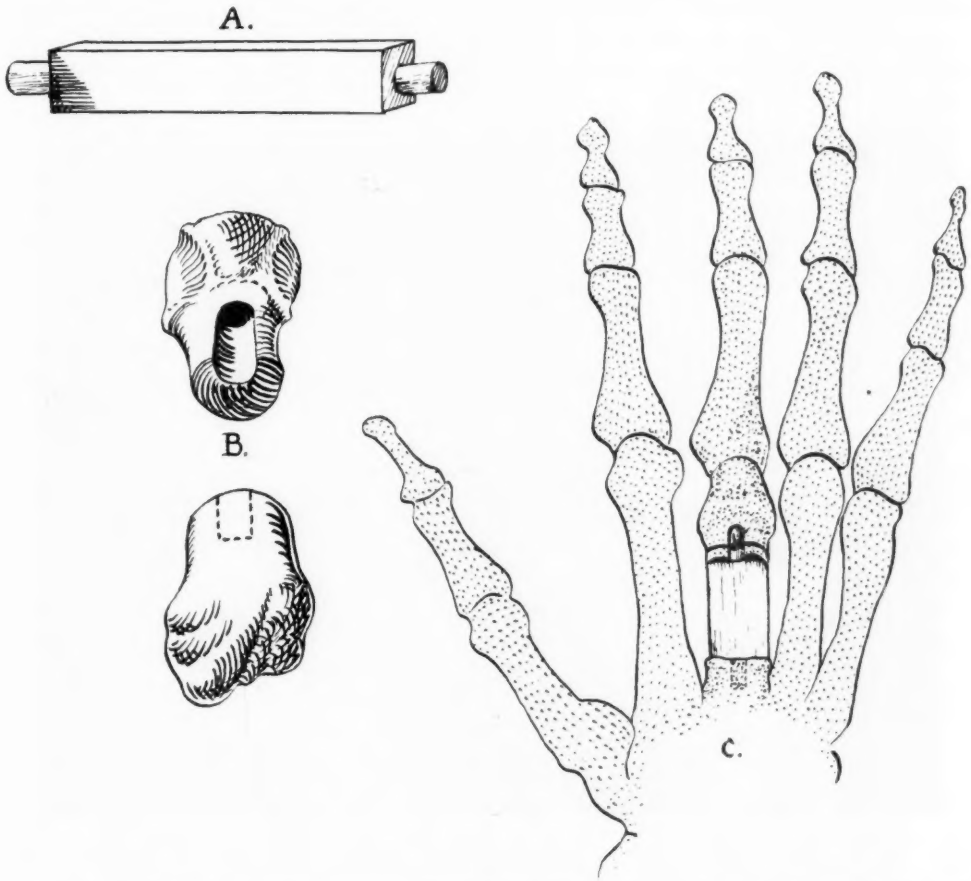


Fig. 1.—Schematic representation of operative technique. *A*, Graft with tenon cut and shaped (obtained from cortex of the tibia). *B*, Distal and proximal metacarpal fragments prepared for reception of graft. *C*, Graft in place, bridging metacarpal defect.

surface of the tibia with a motor saw. The endosteal portion of the graft is removed, leaving only the firm cortex. A shoulder is then cut about both the distal and proximal ends of the graft and the projecting tenon is rounded off. The burr of the Luck motor saw is extremely useful in accomplishing this task. Holding the graft during this procedure is somewhat difficult and Watson-Jones[6] has suggested the use of a small mechanic's vice which can be sterilized and attached to the instrument table; this has been found to be exceedingly

helpful. Each tenon end of the graft when rounded should be of such diameter as to fit snugly within the medullary cavity of the remaining fragments of the metacarpal. Originally, an attempt was made to insert sufficient traction on the digit to allow placement of each tenon of the graft within the medullary canal but this was found to be impossible without breaking up a portion of the distal cortex. By cutting a slot on the dorsal aspect of the distal fragment, the proximal tenon portion of the graft can be inserted in the base of the metacarpal and the distal tenon inlayed in the slot with slight traction on the finger. The tenon is then held within the slot of the distal fragment by a suture of No. 31 stainless steel wire, which is placed through tiny holes made with the smallest cutting burr of the Luck saw, on each side

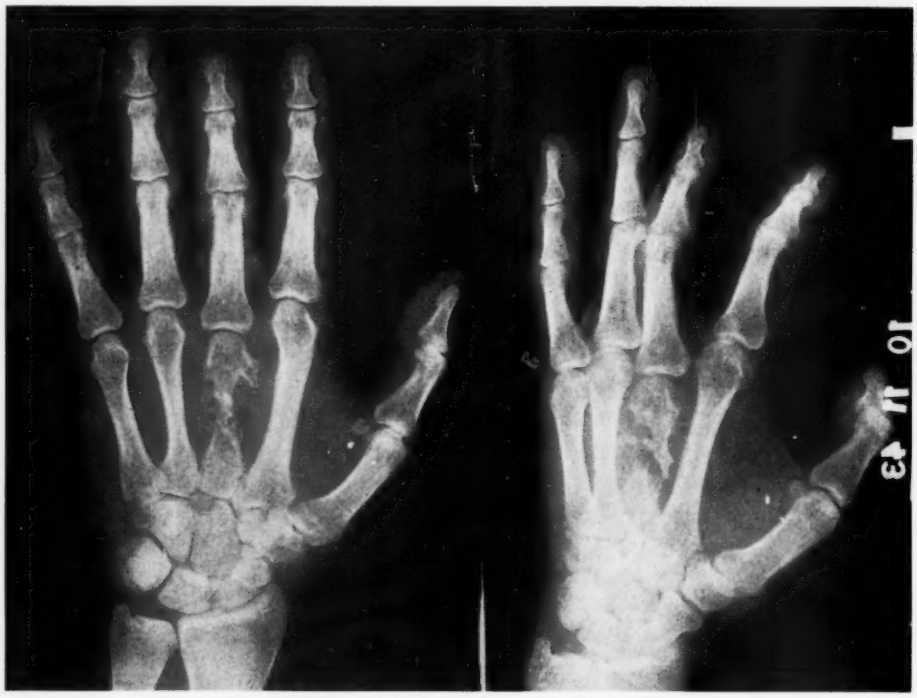

Fig. 2 (Case 1).—Preoperative x-ray view of metacarpal defect, the result of shrapnel wound of hand.

of the cortical portion of the metacarpal fragment. The graft fixed with the stainless steel wire, will be found to be exceedingly firm; the shoulders prevent any shortening of the space between the metacarpal fragments and provide a buttress which prevents shattering of the rather fragile cortex. Placement of the graft can be varied at will. In one instance, the base of the metacarpal being completely absent, the graft was seated into one of the distal rows of carpal bones, maintaining the metacarpal length and giving a very satisfactory result. Sufficient tissue usually can be pulled over the graft between it and the tendons to prevent adherence. The hand is immobilized in a light cast with the wrist in dorsiflexion and the involved digit supported

Fig. 3 (Case 1).—Immediate postoperative x-ray picture of metacarpal defect following tenon and mortise graft.

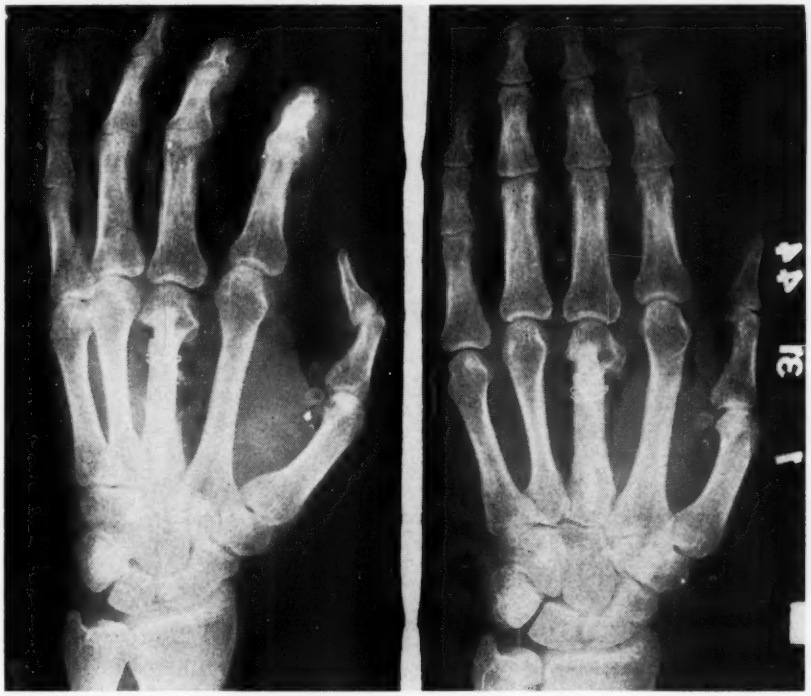

Fig. 4 (Case 1).—Roentgenogram showing firm clinical union of tenon and mortise graft eight weeks postoperatively.

on a curved aluminum splint incorporated in the cast. After approximately four weeks the original cast is removed, the aluminum splint discarded, and a new snug cast fitted; this permits free use of the interphalangeal joints. Union has been obtained in all cases in approximately eight weeks, after which time immobilization is discontinued.

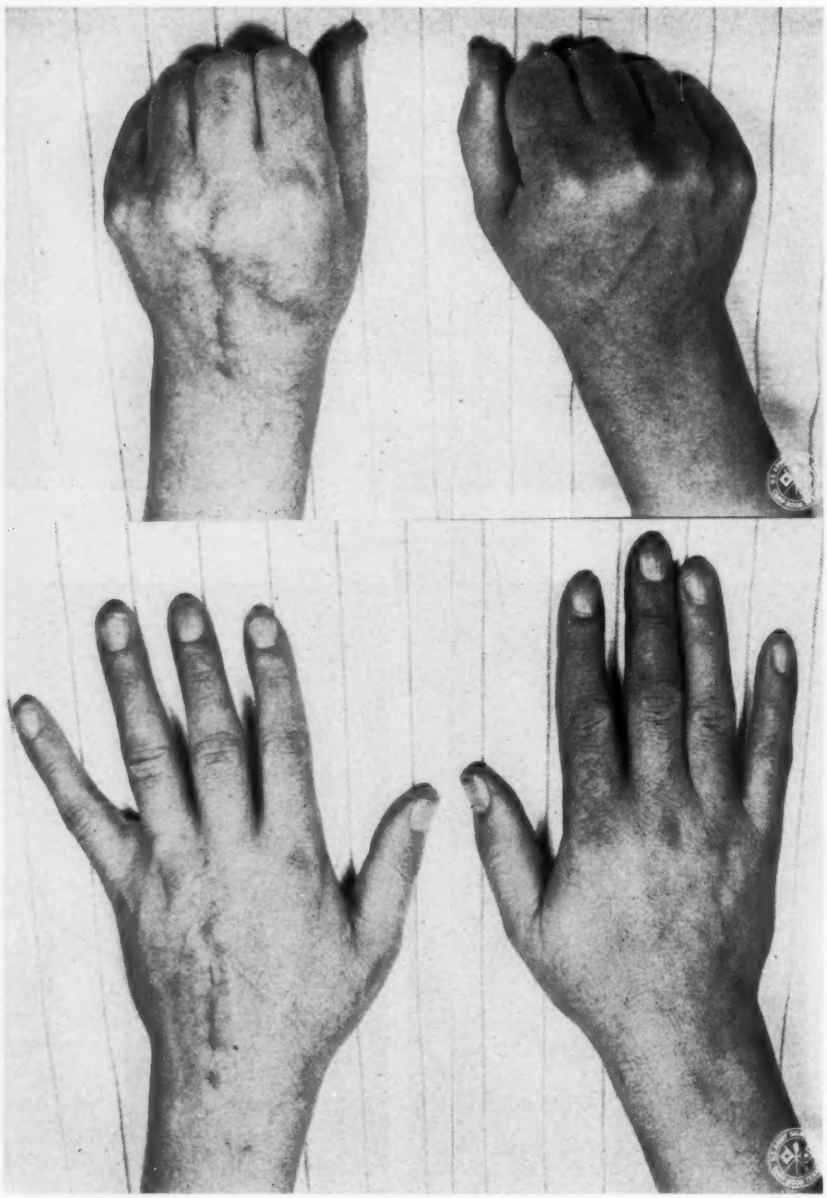

Fig. 5 (Case 1).—Photographs made four months postoperatively, following tenon and mortise graft, illustrating normal function and appearance of hand.

## CASE REPORTS

CASE 1.—A 28-year-old German prisoner of war suffered a gunshot wound of the left hand which resulted in a compound comminuted fracture of the second and third metacarpals, May 16, 1943, during the Tunisian campaign. The fracture of the shaft of the second metacarpal united satisfactorily and in good position. The wound healed by secondary intention without suppuration approximately one month after injury. The patient was admitted to McCloskey General Hospital, Oct. 2, 1943, five months following the original injury. The adherent scar on the dorsum of the hand had been previously excised at a Station Hospital. The roentgenogram on admission revealed loss of substance of the shaft of the third metacarpal, approximately one-third of the length of the shaft, with corresponding shortening of the metacarpal, displacement of the head proximalward, and hyperextension of the metacarpophalangeal joint. The patient was given some physical therapy but sufficient pain was present in the region of the nonunion of the metacarpal to prevent useful function of the hand. Both flexor and extensor tendons of this digit were intact and the sensory nerves were not involved. Dec. 5, 1943, bone graft of the third metacarpal was performed, the technique already described being used. The metacarpal length was satisfactorily restored and the appearance of the hand was satisfactory. All immobilization was completely removed by Jan. 31, 1944, at which time there was firm clinical union substantiated by roentgenography. The patient had been actively using the fingers during the last four weeks of immobilization. After approximately three weeks of physical therapy, complete function of the hand had been restored and the patient was returned to the prisoner of war camp where he was able to perform all types of work.

Fig. 6 (Case 2).—Preoperative x-ray view showing gunshot wound of fourth metacarpal, with loss of distal one-half of shaft.

CASE 2.—A 23-year-old soldier received penetrating bullet wounds on the left hand following discharge of an Italian pistol at Agigente, Sicily, July 21, 1943. Nov. 29, 1943, he was admitted to McCloskey General Hospital, where examination on entrance revealed a dense adherent scar on the dorsum of the hand in the region of the fourth metacarpal

Fig. 7 (Case 2).—Immediate postoperative x-ray picture of tenon and mortise graft, the proixmal end of which was inserted into the hamate bone.

Fig. 8 (Case 2).—Roentgenogram made four months postoperatively, showing firm union of graft.

with practically complete loss of substance of the proximal half of the fourth metacarpal with posterior angulation at the fracture site. The metacarpal head was displaced into the palm with resultant shortening of the digit, hyperextension of the metacarpophalangeal joint, and adherence of the extensor tendons to this digit throughout the length of the scar. Jan. 19, 1944, the scar was excised, the extensor tendons freed in its entirety, and plastic repair of the skin effected. Following this procedure, skeletal traction was applied to the digit in an attempt to secure as much length as possible. May 17, 1944, ten months following injury, a tenon and mortise type bone graft from the tibia was performed. In this instance, due to loss of the base of the metacarpal, the proximal end of the graft was implanted into the hamate bone. Clinical and roentgenographic evidence of union was present in approximately eight weeks, at which time immobilization was discontinued. The patient spent about three months at a convalescent hospital, where he performed all types of mechanical work and by Oct. 8, 1944, had regained approximately 70 per cent of the motion in the metacarpophalangeal joint. The patient was pleased with the cosmetic and functional result and returned to full military duty.

Fig. 9 (Case 2).—Photographs made four months postoperatively, illustrating cosmetic and functional results.

In all, six patients have had the tenon and mortise type tibial graft operation. Each graft has united satisfactorily, there have been no operative complications, and all hands have satisfactory function with the exception of the latest case, in which there was complete loss of the corresponding extensor tendon and which will require a subsequent tendon graft.

## DISCUSSION

The problem of metacarpal fractures due to war wounds has been admirably presented by Howard,[3] who has suggested replacement of the metacarpal shaft by substitution of the proximal phalanx when it is impossible to salvage the digit from a functional standpoint. Murray,[4] reporting a series of metacarpal fractures in which an intramedullary peg was used, stated, "From my experience I prefer the tibial bone because it is stronger. It is better to

work with and provides more secure internal fixation. The fact that all the fractures have united is evidence that while cancellous bone may provide more osteogenic tissue, this cortical bone provides adequate and probably excess osteogenesis." Bunnell[2] used a small key graft for nonunion, which is secured from the dorsal subcutaneous surface of the ulna and fits in the slot prepared in the metacarpal shaft. It is questionable, however, whether this procedure could be used to bridge a large defect. Bunnell stresses the importance of accurate fit and exact carpentry in repairing these small bone defects. Albee[1] devised a method in which a cortical tibial graft was inlayed in a fish mouth in the distal metacarpal fragment and an L-shaped tongue was inlayed in the proximal metacarpal fragment. The graft was held in place by sutures of kangaroo tendon through drill holes in the metacarpal cortex, which was successfully used in bridging the metacarpal shaft defect resulting from resection for extensive osteomyelitis.

Watson-Jones[6] believed that "Although intramedullary peg grafting has no general application and in the case of most bones is far less satisfactory than onlay or inlay grafting, this technique is useful for internal fixation of recent fractures of small tubular bones, that is, the metacarpals, metatarsals, and phalanges."

The tenon and mortise type of graft already described is preferable to the simple intramedullary peg because structurally the graft is considerably stronger and the shoulders on each end of the graft buttress the cortex of the distal and proximal fragments of the metacarpal and prevent crushing of the cancellous bone, particularly of the distal fragment. The well-known cabinetmaker principle involved makes fixation extremely secure with the use of a minimum of foreign material. A graft of this type can be used to bridge a relatively large defect and restore and maintain the normal metacarpal length which is essential in securing a satisfactory cosmetic and functional result.

## SUMMARY

1. The problems of gunshot wounds of the metacarpal bones with shaft defects have been described briefly and the indications for grafting reviewed.

2. A technique of tenon and mortise grafts for bridging metacarpal defects due to gunshot wounds, which has proved satisfactory in six cases, has been described.

3. This type of graft in indicated cases is considerably stronger than the intramedullary peg and provides a satisfactory cosmetic and functional result.

## REFERENCES

1. Albee, F. H.: Bone Graft Surgery, Philadelphia & London, 1915, W. B. Saunders Company.
2. Bunnell, S.: Surgery of the Hand, Philadelphia, 1944, J. B. Lippincott Company.
3. Howard, L. D., Jr.: The Problem of Metacarpal Fractures of the Hand Due to War Wounds; Lectures on Reconstruction Surgery of the Extremities, Ann Arbor, 1944, Edwards Brothers, Inc., p. 196.
4. Murray, G.: Small Bone Grafts of Extremities, Canad. M. A. J. 48: 137-139, 1943.
5. Slocum, D. B., and Pratt, D. R.: The Principles of Amputations of the Fingers and Hand, J. Bone & Joint Surg. 36: 535-546, 1944.
6. Watson-Jones, R.: Fractures and Joint Injuries, ed. 3, Baltimore, 1943, Williams & Wilkins Company.

# TWO UNUSUAL CASES OF WAR WOUNDS OF THE HEART

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TWO rare cases of cardiac wounds are presented which were of more than usual interest. In both, the operative procedures were successful.

## PERFORATING (THROUGH-AND-THROUGH) SHELL FRAGMENT WOUND OF THE LEFT VENTRICLE

CASE 1.—A 22-year-old American private was wounded by an artillery shell fragment at 11:45 A.M., June 27, 1944, near Vincenzo, Italy. He arrived at the Eleventh Field Hospital two hours later, in shock but conscious. There was no dyspnea nor hemoptysis. Nausea with vomiting occurred twice, shortly after admission. Examination showed a 3 cm. lacerated wound in the fifth left intercostal space just outside the midclavicular line. The blood pressure was 80/60. The pulse was 110 and moderately weak but regular. The heart tones were normal and no adventitious sounds were heard. There were signs of fluid in the left pleural cavity. The abdomen was tender and resistant to pressure. A Levine tube was passed into the stomach and 250 c.c. of air and fluid were withdrawn. This material contained no blood. Intravenous plasma was started immediately, followed by blood transfusion. In two and one-half hours, 1,000 c.c. of blood were given. The blood pressure had then risen to 130/70 and the pulse was 90. The abdominal signs and symptoms persisted. Roentgenograms were taken (Fig. 1) and in the lateral projection the shell fragment was lying well posterior, apparently just within the rib cage. From the location of the wound, the apparent course of the missile, and the persisting belly signs, especially nausea and vomiting, a thoracoabdominal wound could not be ruled out. Accordingly, operation was commenced six hours after wounding and three one-half hours after admission to the hospital.

Endotracheal anesthesia consisting of ether vapor and oxygen with carbon dioxide absorption was administered. A blood transfusion of 500 c.c. was given slowly during operation. After débridement, instruments and gloves were changed and an anterior thoracotomy performed in the fifth intercostal space by extending the wound of entrance. There was a chip fracture of the fifth rib. A small contusion of the lingula of the left upper lobe was noted but the diaphragm was intact. Five hundred cubic centimeters of blood were evacuated from the pleural cavity. The shell fragment was then discovered posteriorly, lying free. Two holes were seen in the pericardium: anterolaterally the pericardiophrenic artery and phrenic nerve had been severed (Fig. 2); the posterior laceration was just lateral to the reflection of the parietal pleura from the pericardium on to the mediastinum. Five cubic centimeters of 5 per cent procaine were instilled into the pericardial sac, which was then opened by vertical incision after several minutes. There were two 8 mm. lacerated wounds of the left ventricle, both oozing blood with each systole. The wound of entrance was at the apex; that of exit was in the mid-portion of the left ventricular wall posteriorly (Fig. 3). The apex of the heart was rotated 90 degrees forward and steadied by the right hand of the assistant. The posterior wound was exposed between the spread second and third fingers and the bleeding controlled by two No. 0 silk sutures (Fig. 4). A small venous branch was occluded by the sutures. The anterior laceration was irregular and the muscle gaped slightly. Oozing continued, particularly after one suture had cut partially through the muscle. The bleeding was controlled by fashioning a small pedicled graft of anterior pericardium and pericardial fat which was then sutured over the laceration (Fig. 5). Extra systoles were numerous while the heart was being handled but they ceased immediately. Five grams of crystalline sulfanilamide and 50,000 units of penicillin were placed in the pleural cavity. Two water-trap drainage tubes were used: a small mushroom catheter in the second intercostal space anteriorly; and a one-quarter inch fenestrated tube in the eighth intercostal space in the midaxillary line. The latter tube was clamped off for eight hours

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following surgery to allow for time contact of the chemotherapeutic agents. The incision was closed in layers using interrupted silk. Pericostal sutures were not employed. The operation was slightly more than two hours in length. At its conclusion the blood pressure was 110/70, the pulse, 145, and respiration, 32.

Following operation, nasal oxygen was administered for twenty-four hours. The anterior catheter was removed in seventy-two hours and the posterior tube on the fifth postoperative day. There had been 2,000 c.c. of serosanguineous drainage during this time. The blood pressure remained normal and the pulse stabilized at 100 to 110. Cardiac irregularities were never demonstrated. Twenty-four hours after operation a splash was heard over the precordium, synchronous with systole. Four days later a loud precordial friction rub was audible for twenty-four hours. At this time also the second sound in the pulmonic area was occasionally reduplicated. On the sixth postoperative day there was slight roughening of the first sound at the apex and a poorly transmitted soft systolic murmur was heard in this area.

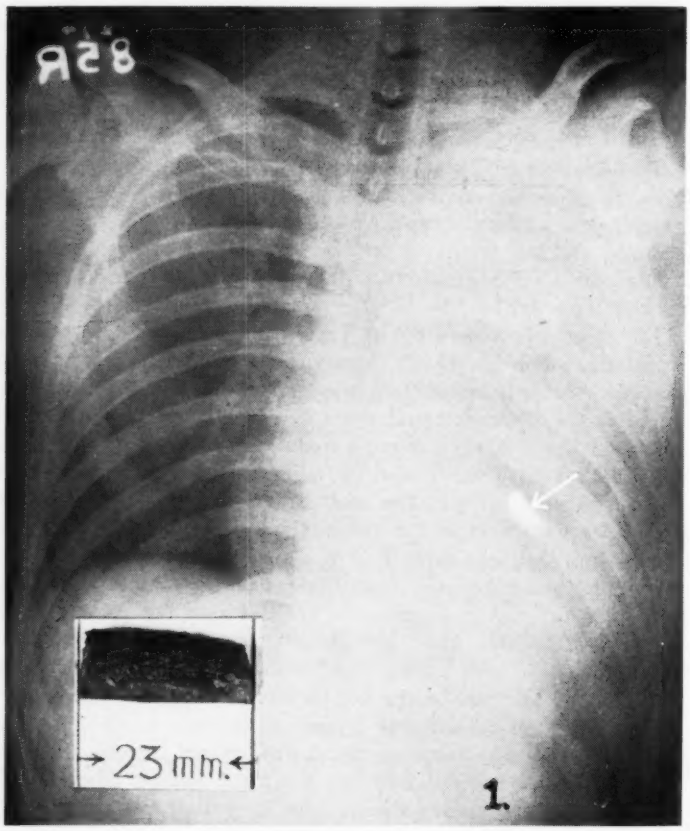


Fig. 1.—Frontal view; there is a large hemothorax on the left which obscures the lung. The shell fragment (insert) measures 23 by 10 by 4 mm. and lies at the ninth rib posteriorly. The Levine tube is seen faintly at the level of the eleventh intercostal space on the left.

An electrocardiogram was made at the Sixth General Hospital twelve days after operation. The rhythm was normal and the rate, 80. Moderate inversion of T waves, with elevated S-T intervals in the first three leads, was reported. The T wave was normal in Lead IV. There was moderate left axis deviation. The patient became ambulatory three weeks after operation. A scratchy to-and-fro precordial friction rub was heard intermittently for an additional two weeks. Further observations were made at the 300th Gen-

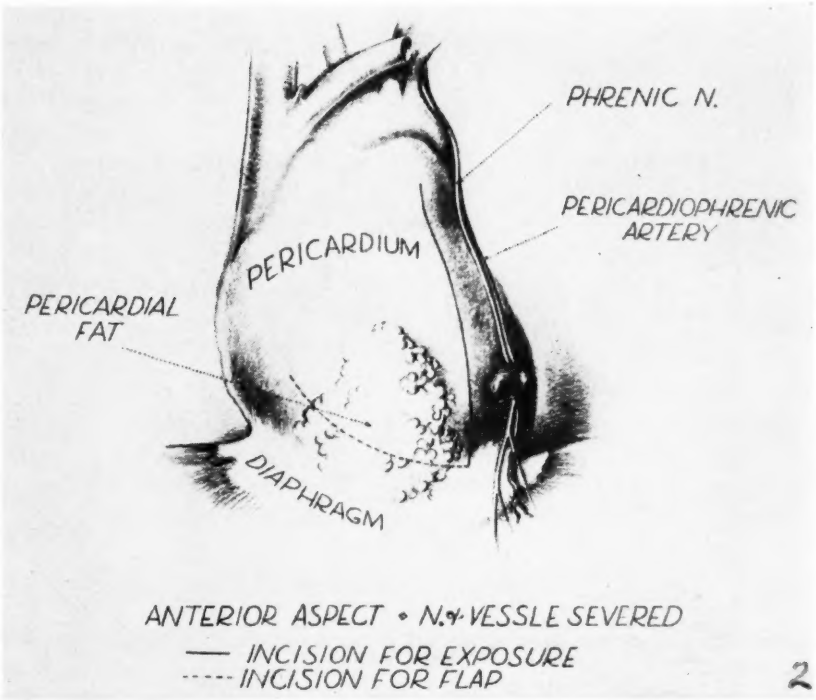


Fig. 2.—Drawing at operation showing the anterolateral laceration of the pericardium (wound of entrance) and the severed pericardiophrenic artery and phrenic nerve.

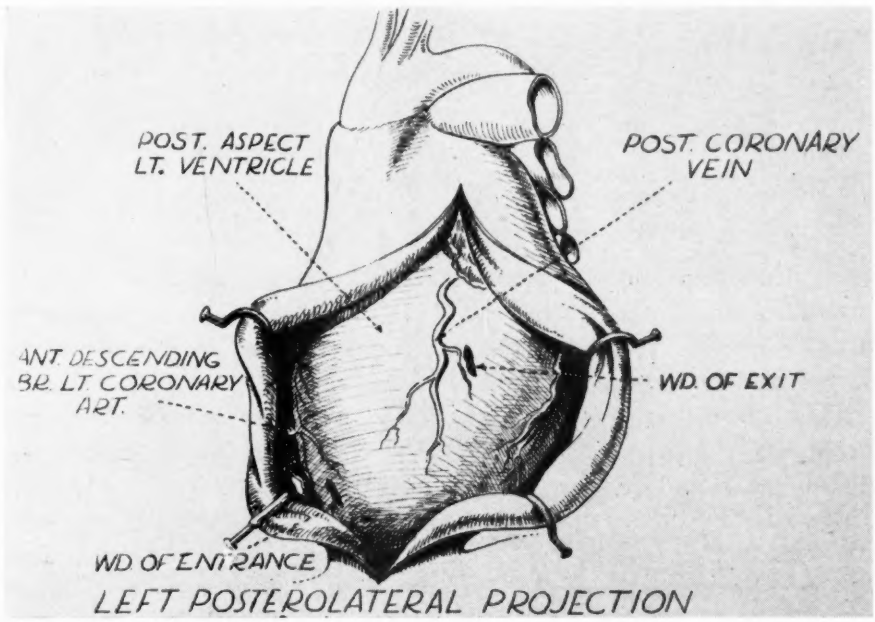


Fig. 3.—Semidiagrammatic drawing of heart as though viewed from left posterolateral aspect, showing relationship of wounds to important vessels.

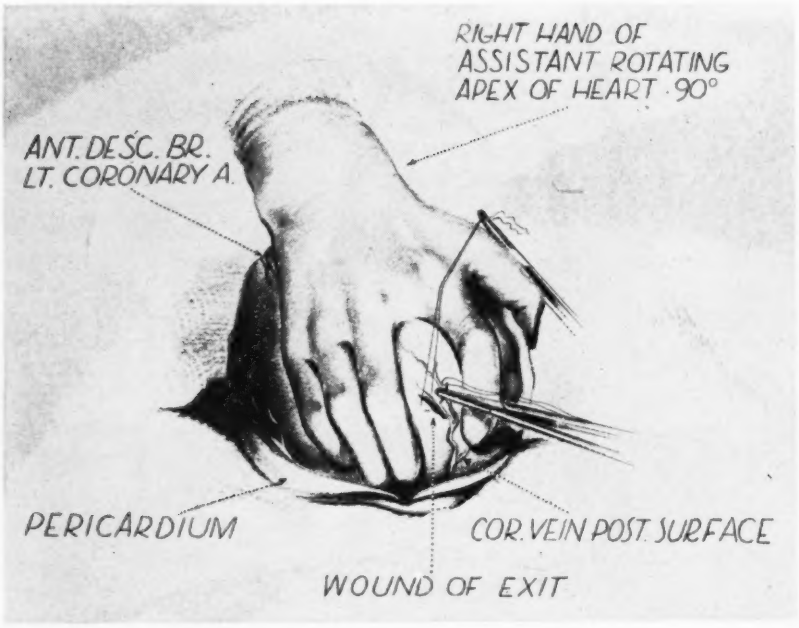


Fig. 4.—Drawing at operation showing method of steadying heart, with exposure of posterior laceration.

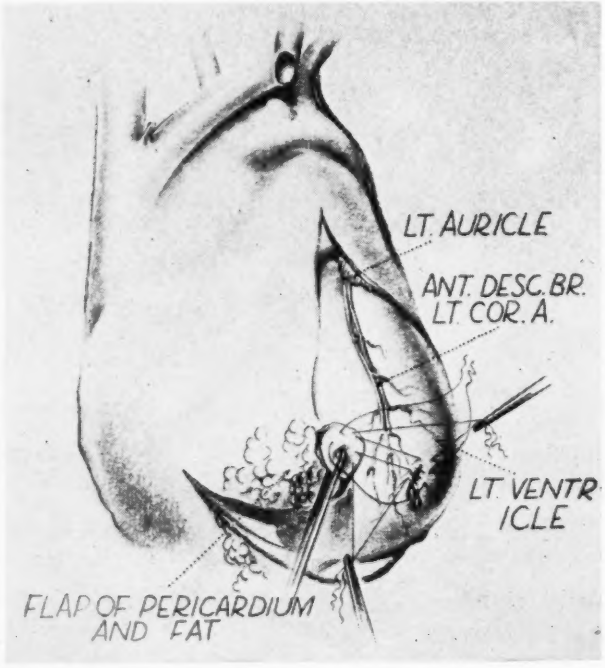


Fig. 5.—Drawing at operation; the pedicled graft of pericardium is being sutured over the anterior lacerated wound.

eral Hospital. The lung fields were clear and the heart was not enlarged (Fig. 6). Auscultation revealed neither friction rub nor murmurs. An electrocardiogram showed mild myocardial damage, with improvement over the previous tracing. No signs of cardiac embarrassment developed with increased activity. The patient was evacuated to the United States eleven weeks after operation.

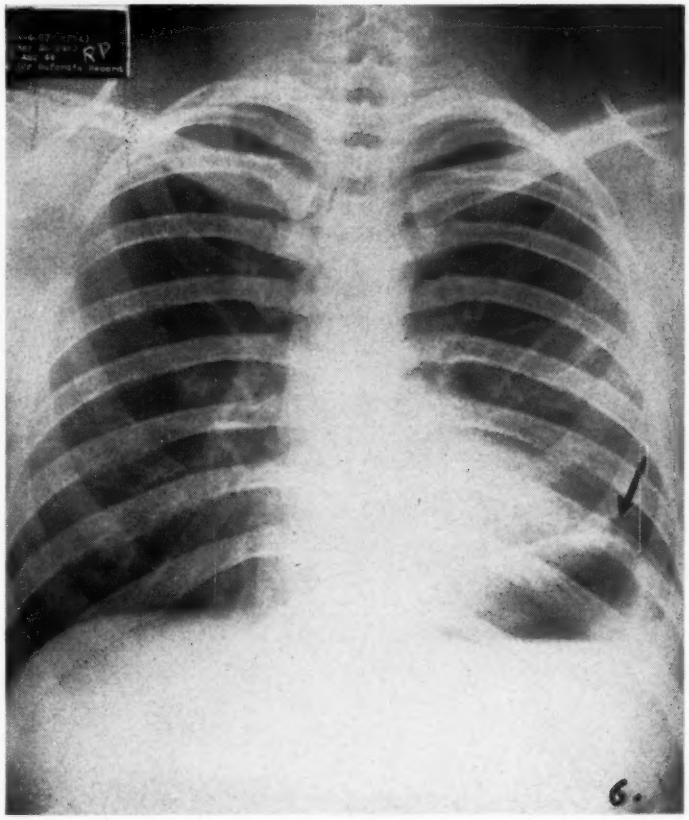


Fig. 6.—Frontal view, eight weeks following operation. The lung fields are clear; the left diaphragm is elevated and paralyzed; there is no cardiac enlargement. The chip fracture of the fifth rib anteriorly can be seen (arrow).

*Comment.*—It has been of interest to us that severe perforating wounds of the heart are not necessarily fatal. That this patient survived his original wound seems to have been due to a rare chain of circumstances. The fragment must have struck end on and passed through the heart without revolving. It seems probable, too, that the heart was pierced during diastole, which permitted traverse of the chamber without damaging irreparably the papillary muscle. The case also demonstrates that there may be few if any localizing signs or symptoms in spite of a serious cardiac wound. In retrospect one should consider that the patient's nausea and vomiting were probably cardiac in origin. These symptoms are uncommon in pure thoracic injuries. With the shell fragment free in the pleural cavity the apparent course of the missile was entirely misleading. Had the missile struck from directly in front

it could not have failed to penetrate the diaphragm. The fragment, however, had come from the left, passed through the heart, and then fallen free in the pleural cavity, almost opposite the wound of entrance in an anteroposterior plane.

No published reports on perforating shell fragment wounds of the heart have been found. Boyden[1] recently has described a case similar to the one just reported, of perforating wounds of the left ventricle in which a branch of the posterior circumflex artery had been severed. Both wounds were sutured and the patient survived. Records of at least four other perforating cardiac

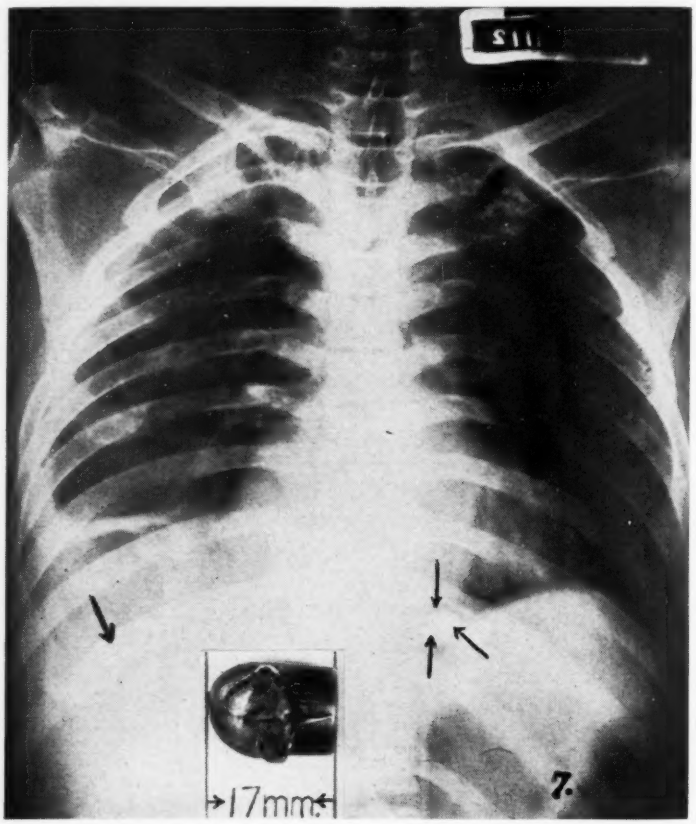


Fig. 7.—Frontal projection; there is a fracture of the tenth rib posteriorly on the right (arrow) and a small right-sided hemothorax. The blurred foreign body (arrows) is seen lying 5 cm. to the left of the midline. Insert shows the removed 45 caliber bullet, 17 by 10 mm. The nose is blunted and roughened, apparently due to ricochet from a solid object.

wounds are now at hand in which the patient lived long enough to reach a forward hospital.[2] In one of these the interventricular septum had been traversed. It has not been possible to determine the incidence of perforating cardiac wounds in civil practice. Undoubtedly some of the cases listed by Elkin, Bigger, and others were perforating in type. Probably one of the earliest examples of operative success was that reported by Launay (1902)[3] in which the wound was self-inflicted. The bullet was found to have passed through the left ventricle. Both wounds were repaired and the patient recovered.

INTRAVENTRICULAR METALLIC FOREIGN BODY

CASE 2.—On Nov. 21, 1944, a 38-year-old German sergeant was wounded in the right chest posteriorly by a 45 caliber bullet as he was ascending from a dugout. The bullet apparently ricochetted before striking him. The prisoner was knocked down by the impact but did not lose consciousness. Except for hemoptysis and moderate dyspnea he suffered little discomfort. The patient was admitted to the Ninth Evacuation Hospital five days after wounding. Examination showed a 3 cm. superficially infected, lacerated wound over the tenth right rib in the midscapular line. There were signs of fluid at the right base. The blood pressure was 120/78, and the pulse was 90 and regular. No cardiac pathology could be detected. Roentgenograms in frontal and lateral projections were made (Figs. 7 and 8). At fluoroscopy the foreign body descended slightly on inspiration. It could be separated from the diaphragm but remained always within the cardiac shadow. During systole there was a 3 cm. excursion of the missile from left to right, with return to the original position during diastole. The location and movement of the foreign body did not vary at two subsequent fluoroscopies. These studies demonstrated that the bullet was in the heart.

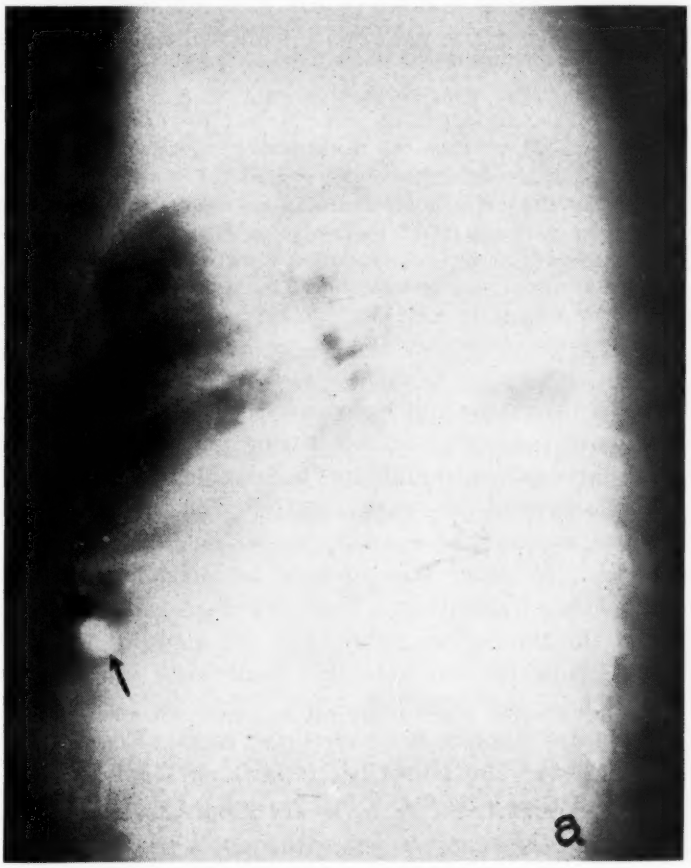


Fig. 8.—Left lateral projection; the blurred foreign body (arrows) is seen lying 4.5 cm. beneath the skin surface anteriorly.

Operation was undertaken seven days after wounding. Closed endotracheal anesthesia of ether vapor and oxygen was given. An anterior left-sided approach was used since the foreign body lay to the left of the midline. Incision was made from the sternum to the midaxilla and the left pleural cavity was entered through the fifth intercostal space. The

internal mammary vessels were ligated and divided. The pericardial sac was opened by a vertical incision anterior to the phrenic nerve. It contained a few cubic centimeters of serous fluid. Ten cubic centimeters of 5 per cent procaine were instilled. No lacerations either of the pericardium or of the myocardium were demonstrated. During diastole the missile could be palpated through the wall of the right ventricle, 3 cm. to the right of the apex. Its position was checked with a fine needle. The heart was steadied in the left hand by the "palming" method.[4] A 1.2 cm. incision, parallel to the inferior cardiac border, was made down to the foreign body. It was grasped with forceps and removed. There was an immediate gush of blood from the chamber of the right ventricle. This was controlled by thumb pressure while three No. 0 interrupted silk sutures were rapidly inserted and tied by the assistant. There was no further bleeding. Dilatation and ectopic beats developed during cardiac manipulation but there was spontaneous return to normal rhythm when the heart was released. The pericardium was closed above, and opened posterior to the phrenic nerve for more dependent drainage. Anterior and posterolateral drainage tubes were inserted and 25,000 c.c. of penicillin were injected into the pleural cavity. The incision was closed in layers using interrupted silk. The operation consumed one hour and fifty minutes. At its finish the blood pressure was 98/68, and the pulse 100 and regular. Five hundred cubic centimeters of whole blood were given slowly during operation.

The postoperative course was complicated only by a superficial infection in the thoracotomy incision. The lung expanded promptly and the drainage tubes were removed on the second and third days. Bilateral thoracentesis on the fourth day was productive of 150 c.c. of clear serum on the left and 250 c.c. of old blood on the right. The heart remained regular and no friction rub was heard at any time. The patient was transferred to the Twenty-first General Hospital for study. An electrocardiogram which was taken twelve days following operation showed myocardial damage. The QRS complex was slurred in Lead III and the T waves were inverted in all leads, with coning of the S-T segments. There was marked low voltage in Lead III. The patient was discharged to ambulatory convalescence in a prisoner of war hospital, ten weeks after operation.

*Comment.*—In Case 2 the bullet obviously did not traverse the myocardium. In view of the bullet's size and known hitting power, residual damage to the pericardium and myocardium would have been evident seven days after wounding had the missile entered the heart directly. The foreign body undoubtedly entered the venous system just outside the pericardium and was washed into the right ventricle. Whether the superior or inferior vena cava was penetrated cannot be stated definitely. Unknown factors are the exact position of the soldier at the time of wounding and the angle at which the shot was fired. Since the tenth rib was fractured posteriorly the inferior vena cava easily could have been the portal of entry. That its force was spent is evidenced by the blunted nose of the bullet (see insert, Fig. 7), indicating that it had glanced off some solid object before striking the soldier.

Indications for removing foreign bodies from the cardiac chambers have not been clarified. Cardiotomy is not without risk and many of the missiles may remain asymptomatic. On the other hand, delayed complications and fatalities have occurred due to the continued presence of a foreign body. The intracardiac missile may be the cause of fatal secondary pulmonary emboli.[5] Lyle[6] reported a case in which a shell fragment entered the left femoral vein and came to rest in the right heart. A generalized "gas" infection from this focus resulted in death. Jarvis[7] has described a case in which a shell frag-

ment entered the vascular system through the inferior vena cava in the abdomen. The patient died suddenly ten days after injury and at autopsy the irregular foreign body 20 by 15 by 10 mm. was found in the right ventricle. The myocardium of the right ventricle near the apex was extensively softened and hemorrhagic in the area overlying the missile.

Certain hazards also must be expected if the fragment enters the pulmonary circulation from the right heart. While I have no personal knowledge of such a case, it is theoretically possible for the missile itself to become an embolus which is immediately fatal. The removal of foreign bodies from the pulmonary vessels may be difficult and involve the loss of an essential artery. Lobectomy or even pneumonectomy might become necessary under certain conditions. In one of Burford's cases[8] it was felt unwise to remove an asymptomatic missile which had become lodged in the right main pulmonary artery because of the likelihood that the artery would have to be sacrificed.

Harken[9] has removed a number of foreign bodies successfully from various chambers of the heart. Unless localizing cardiac symptoms persist, the operation, in most instances, should not be considered an emergency. In general, it is preferable to transfer the patient to a special base section hospital where there may be better facilities for study and for continuity in postoperative care. Final conclusions as to indications for cardiotomy must await eventual critical comparison between the results from operation and those from conservative management.

## SUMMARY

Two cases of unusual cardiac wounds have been presented and the surgical treatment described. The first patient suffered a perforating (through-and-through) shell fragment wound of the left ventricle. Both wounds were sutured and the soldier survived. In the second patient a 45 caliber bullet entered the venous system just outside the pericardium and came to rest in the right ventricle. The missile was removed by incision through the ventricular wall. The patient made an uneventful recovery.

The author is indebted to Technician Fourth Grade Walter Meigs, Jr., who made the drawings which are reproduced in this paper.

## REFERENCES

1. Boyden, Allen A.: Personal communication; operation by W. P. Jennings and Boyden.
2. Case Records of the Second Auxiliary Surgical Group: Unpublished data.
3. Launay: Gaz. d. hôp. **75:** 926, 1902; quoted by Lilienthal.[4]
4. Lilienthal, Howard: Thoracic Surgery, vol. I, Philadelphia, 1925, W. B. Saunders Company, page 448.
5. Tuffier, T.: V^e^ Cong. de la Soc. internat. de chir., Paris, p. 46, Paris.
6. Lyle, H. H. M.: Ann. Surg. **64:** 734, 1916; quoted by Lilienthal.[4]
7. Jarvis, Fred J.: Personal communication.
8. Burford, Thomas H.: Personal communication.
9. Harken, Dwight: Personal communication. See also J. Thoracic Surg. **15:** 31, 1946.

# THE EFFECT OF ATROPINE ON THE GASTRIC SECRETION FOLLOWING THERMAL TRAUMA

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VOMITING, occult blood in the stools, and the development of peptic ulcers (Curling's ulcer) have been described following burns in the human being.[1-2] In the dog, a significant increase of gastric motility, particularly of the gastric antrum, has been found. Gastric secretion was increased in these animals when intravenous infusions had been administered. The secretions seemed to be higher when the animals had been fed the night before the experiment. The strong gastric motility following burns was not abolished by section of the vagus or of the splanchnic nerves. It was abolished, however, by the injection of relatively small doses of atropine. On the basis of this work, the use of atropine in the treatment of patients with burns was suggested, because it was felt that the intense motility of the stomach, and particularly of its pyloric part, might lead to ulcerations.[3, 4] Since the effects of atropine on the gastric secretion following burns are not known, they were investigated in the present study.

## EXPERIMENTAL PROCEDURE

Normal mongrel dogs, fed eight to nine hours before the experiment, were anesthetized with pentobarbital sodium (nembutal) and were kept under anesthesia during the entire experiment. Unless the animals died, they were destroyed painlessly at the termination of the experiment. The hair was clipped over the area to be traumatized. The esophagus was ligated in the neck and a cannula was inserted into the pylorus. The cannula was directed to the outside so that the gastric juice could be drained into a bottle; volume and acidity were determined periodically. Intravenous infusions were given at constant rates,[5] most animals receiving 1 c.c. per minute per kilogram of body weight of either 0.9 per cent saline or 5 per cent glucose solution, or a mixture of both. Fifteen minutes before the burn, 5 or 10 mg. of atropine sulfate were injected intravenously and every half hour after the burn doses of 5 mg. were given (slow rate of injection). Thermal trauma was administered by torch to approximately 50 per cent of the body surface. The duration of the traumatization varied between ten and twenty minutes, but it is not believed that this expresses the degree of traumatization, because a number of other factors like thickness of the skin, of the subcutis and fat layers, of the musculature, etc., seem to affect penetration of heat. Autopsies were performed on all animals. Control experiments were performed on two anesthetized dogs. The procedures were the same as in the burn experiments, except that no trauma was applied.

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## RESULTS

In the control experiments, the volume of secretion per hour (collected through a cannula) varied between 1 and 4 c.c. No free acidity and small or medium amounts of total acidity were found. Four similar control experiments, reported in our previous work,[3] are included in the lower part of Table I. The volume of secretion in the earlier experiments was within the magnitude of the secretion observed in the present controls, and no free acidity was present. Thus, considerable changes in the secretion following burns were assumed not to be due to conditions of the experiments other than the burn.

TABLE I. CONTROLS—GASTRIC SECRETION WITHOUT THERMAL TRAUMA

| NUMBER OF DOGS | SECRETION IN C.C. PER HOUR | | | | ACIDITY IN M.E. HCl (FREE—TOTAL) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1ST | 2ND | 3RD | AV. | 1ST | 2ND | 3RD | AV. |
| 1 | 1.5 | 1.0 | 4.0 | 1.2 | 0-55 | 0-40 | 0-20 | 0-38 |
| 1 | 4.0 | 2.5 | 1.0 | 2.5 | 0-10 | 0-5 | 0-5 | 0-7 |
| 4 | | | | 2.9 | | | | 0 |

In Table II is represented the summary of twenty-four experiments with thermal trauma. Twelve control experiments without drug administration were performed, and in twelve experiments atropine was given. In most instances the greater part of the secretion following the trauma occurred within the first thirty minutes after the burn, while a smaller fraction was secreted or evacuated during the remainder of the period of observation.

TABLE II. GASTRIC SECRETION FOLLOWING THERMAL TRAUMA

| PROCEDURE | NUMBER OF EXPERIMENTS | DURATION IN MIN. | | VOLUME SECRETION IN C.C. | | FREE ACID IN M.E. HCl | | TOTAL ACID IN M.E. HCl | |
|---|---|---|---|---|---|---|---|---|---|
| | | BEFORE BURN | AFTER BURN | BEFORE BURN | AFTER BURN | BEFORE BURN | AFTER BURN | BEFORE BURN | AFTER BURN |
| No atropine | 12 | 80 (60-120) | 100 (60-155) | 10 (0.1-35) | 26 (0.5-60) | 0 | 7 (0-40) | 23 (1-75) | 48 (10-150) |
| Atropine sulfate | 12 | 94 (60-120) | 97 (60-120) | 10 (1-31) | 26 (3-120) | 4 (0-35) | 13 (0-70) | 31 (5-100) | 46 (20-140) |

Average values; minimal and maximal variations in brackets.

## DISCUSSION AND CONCLUSIONS

The data in Table II show that atropine had no effect on the volume and acidity of secretion following thermal trauma, although the doses of atropine (up to 30 mg.) were large in comparison to those which in our previous observations completely suppressed the gastric motility following burns (2 mg.). After the burn, the average free acidity did not rise much, while total acidity showed a somewhat larger increase, irrespective of whether atropine had been administered or not.

In our previous work we had assumed that the gastric hypermotility of burns was due to a cholinergic mechanism, because it was abolished readily by atropine.[3] The present observation that relatively large doses of atropine do not depress the increased gastric secretion of fluid and acid following a torch

burn indicates that we may be dealing with a histamine-like substance liberated by the burn, the gastric secretory effects of which are not abolished by atropine. It appears thus, that the gastric secretion and the gastric motility of burns in dogs are activated by two different mechanisms.

Assuming that our experience in the dog can be applied to man, we have recommended atropine against the vomiting and other gastrointestinal symptoms following burns in the human being which, we believe, may lead to mucosal hemorrhage and to the development of acute ulcers which later may become subacute and bleed or perforate. Following our present experience with the ineffectiveness of atropine on the increased gastric secretion following burns we feel that we should recommend the use of antacids in addition to atropine. Such therapy would take care of both the increased motility and the increased secretion of burns. Atropine may have other more general effects in shock. The drug has been reported to prolong the life of rats subjected to traumatic shock,[6] and we have gained the same impression in unpublished series of experiments.

## SUMMARY

Relatively large doses of atropine did not affect the increased gastric secretion of the dog's stomach following burns. Since gastric hypermotility of burns is suppressed completely by atropine, it is assumed that, in burns, two different mechanisms activate gastric secretion and gastric motility. Gastric motility of burns may be due to a cholinergic mechanism, and gastric secretion of burns may be due to a histaminic mechanism.

If these findings can be applied to the human being, atropine and an antacid are recommended in cases of burns, in order to prevent vomiting, gastrointestinal hemorrhages, and the formation of ulcer.

## REFERENCES

1. Cope, O., and Rhinelander, F. W.: The Problem of Burn Shock Complicated by Pulmonary Damage, Ann. Surg. **117**: 715, 1943.
2. Harkins, H. N.: Acute Ulcer of the Duodenum (Curling's Ulcer) as a Complication of Burns: Relation to Sepsis, SURGERY **3**: 608, 1938.
3. Necheles, H., and Olson, W.: Experimental Investigation of Gastrointestinal Secretions and Motility Following Burns and Their Relation to Ulcer, SURGERY **11**: 751, 1942.
4. Necheles, H., and Olson, Wm. H.: Studies on the Pathological Physiology of Burns, Illinois M. J. **84**: 6, 1943.
5. Necheles, H., and Olson, Wm. H.: A Simple Constant Injection Pump, J. Lab. & Clin. Med. **26**: 1647, 1941.
6. Zahl, P. A., Hütner, S. H., and Cooper, F. S.: Noble-Collip Shock: Therapeutic Effects With Autonomic Depressants; Motion Factors, J. Pharmacol. & Exper. Therap. **77**: 143, 1943.

# BILATERAL POPLITEAL HERNIA

## Case Report

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THIS case report is of special interest because of the rarity of bilateral popliteal herniation of the knee joint. It is believed that this represents only the second case reported. Haggart, who has published articles on this condition, mentions one other bilateral case.[1] The condition probably is not considered very frequently in diagnosis of popliteal swellings.

A popliteal hernia is generally defined as a synovial outpouching of a cystlike structure through the knee joint capsule, which causes symptoms suggesting an internal derangement of the knee. The term Baker's cyst is frequently used in the British publications to describe any cystic swelling about the posterior knee joint which is lined with synovium.[1] However, in these publications the cysts referred to are enlargements of the bursae in that area. In popliteal hernia the cyst is a protrusion of the synovial membrane of the joint through the joint capsule.

According to Haggart, the etiologic factors of herniation of the knee joint capsule are trauma, especially sudden trauma associated with forceful hyperextension of the knee joint, and perhaps some congenital defect.[2] It is commonly associated with hypertrophic arthritis in the knee joint.

Pathologically, this portion of the capsule is thickened, fibrotic, and typically lined with a mesothelial membrane similar to the synovial membrane of the knee joint itself. Acute and chronic inflammatory changes are noted in the sac wall with round-cell infiltration being most notable. Grossly, the sac is usually adherent to the medial head of the gastrocnemius muscle. The neck of the sac communicates with the knee joint and may be dissected free with care.

Clinically, the patient presents symptoms of discomfort and aches in the knee joint. The posterior portion of the knee joint swells and walking is a painful procedure. The lower leg and ankle swell intermittently, apparently from the pressure of the popliteal mass on the venous system.

Physical examination shows a cystic swelling posterior and distal to the transverse flexion crease of the knee. The mass feels like an elastic ball and is frequently reducible when the knee is flexed. Roentgenograms of the knee joint are noncontributory to the diagnosis.

In differential diagnosis it is important to recognize that the semimembranosus bursa which occasionally swells is more medial than the typical popliteal herniation, while the semitendinosus bursa is more lateral. It should also be kept in mind that aneurysms have a typical pulsation. Gelatinous fluid can be aspirated with a syringe from the hernial sac. If the cyst con-

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tents can be reduced into the joint with the knee flexed, the diagnosis is obviously hernia.

The treatment of choice is operative excision of the hernia with ligation and closure of the neck of the sac. The capsule is then reconstructed with sutures.

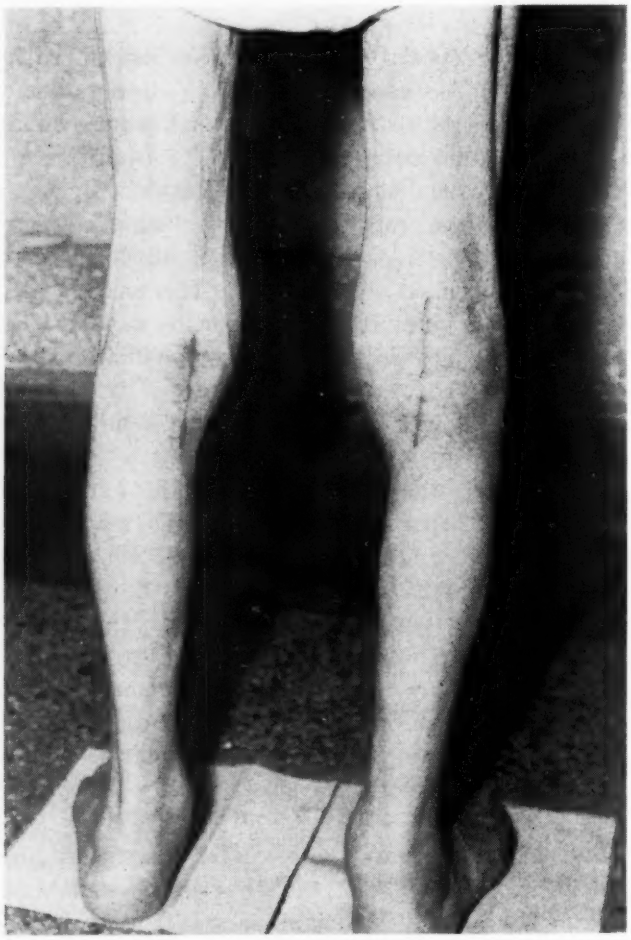

Fig. 1.—Postoperative result.

CASE REPORT

An 80-year-old man came to the Mandel Clinic of Michael Reese Hospital complaining of progressive pain and swelling of both knees, with discomfort and difficulty in walking, over a period of three months. No history of trauma was elicited. The patient had a generalized hypertrophic arthritis of the fingers, elbows, and knees. On admission he could walk only with short painful steps.

Past history revealed nothing related to the present disability.

Physical examination disclosed blood pressure to be 130/70, pulse 82, and respirations 20. The patient was not acutely ill, but obviously had difficulty in walking and used

a cane for support. His steps were measured and painful. Essential findings were scoliosis to the left side of the thoracic spine, and hypertrophic arthritis of the hands, knees, and ankles with some valgus deformity of the knees. The popliteal space bilaterally contained egg-sized, firm, smooth, elastic and somewhat movable tumor masses, not attached to the skin. The mass on the left side was reducible with flexion. The presumptive diagnosis was bilateral popliteal hernia.

The operation consisted of a posteriorly placed longitudinal incision down to the deep fascia of the left knee (Fig. 1). The fascia was incised and the cystic mass presented itself. The mass was dissected from the adjacent tissues by blunt and sharp dissection. The lateral and medial heads of the gastrocnemius muscle were retracted and at its superior portion the sac was firmly adherent by fibrous strands to the fascia of the medial head of the gastrocnemius muscle. Superiorly the cystic mass terminated in a neck which communicated with the joint of the left knee just lateral to the semimembranosus muscle. This was a herniation of the synovial membrane through the knee joint capsule. The sac contents could be completely reduced and its contents could be transferred back and forth into the knee joint. The sac was dissected free at its neck. The neck of the sac was closed with interrupted chromic catgut sutures which inverted the edges, and the capsule of the knee joint was also closed with fine interrupted chromic sutures. Hemostasis was good. Fascia was closed and the skin was closed with dermal sutures. Firm pressure dressings were placed on the incision. The right knee was operated upon in a similar manner. However, the lining of the neck of the sac of the right knee was obliterated by adhesions and constricted so that the sac contents were not reducible. The fluid in the sac was gelatinous with pearly particles much like villi floating about.

The postoperative course was uneventful. Because the patient was an old man, early motion was thought to be very important. This is a departure from the full extension splint which Haggart uses. On the first postoperative day the patient was placed in a wheel chair. Therapeutic light treatments were given to both knees daily. By the fourth postoperative day most of the pain was gone and the patient was quite comfortable. On the sixth postoperative day, sutures were removed. The wound healed very well. Edema was minimal. On the tenth day the patient was discharged. At subsequent follow-up visits, the elderly patient has been found to be much happier, entirely relieved of the distressing knee pain, and now able to walk with ease.

## SUMMARY

1. An unusual case of bilateral knee joint hernia into the popliteal space is reported.

2. The distressing symptoms of this condition can be relieved by surgical removal of the hernia sac and repair of the capsule defect.

## REFERENCES

1. Haggart, G. E.: Posterior Herniation of Knee Joint; A Cause of Internal Derangement of the Knee, J. Bone & Joint Surg. **20**: 263-273, 1938.
2. Haggart, G. E.: Synovial Cysts of the Popliteal Space; Clinical Significance and Treatment, Ann. Surg. **118**: 438-445, 1943.

# CLOSURE OF THE COLOSTOMY STOMA

## A Simplified Plan of Management

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CLOSURE of the colonic stoma, as seen in the wounded soldier, presents two main problems: (1) What technique is applicable to the various types of colostomies seen? (2) Of what value is chemotherapy in conjunction with closure of these stomas?

We wish to present the plan of management of colostomy closure which we have followed in the past twenty-three colostomes. We would point out that the technique of closure should be chosen for each patient according to the type of colostomy present as revealed by digital examination. Chemotherapy has proved its worth in our hands in the prevention of infection and promotion of healing.

Concerning the technique of closure, Keene[3] has recently advocated and reported excellent results in resecting the bowel involving the stoma, and restoring continuity of the colon by end-to-end suture. Coller and Vaughan[1] stated that they had resorted to end-to-end union for colostomy closure with gratifying results. Both Coller and Vaughan[1] and Pemberton and Black[4] have advocated the use of delayed closure of the abdominal wound.

The first large series of colostomy closures in which the effect of chemotherapy was seriously evaluated was reported by Dixon and Benson[2] in 1944. By the preoperative use of succinylsulfathiazole in the field of operation they were able to reduce wound infection from 84 to 13 per cent, fecal drainage from 30 to 2 per cent, mortality from 3 to 0 per cent.

Stimulated by our observation of the beneficial effects of chemotherapy in secondary wound suture, we have adopted both penicillin and sulfonamide therapy for colostomy closure.

### PREOPERATIVE AND POSTOPERATIVE MANAGEMENT

Each patient was placed on a definite preoperative routine, as soon as the colostomy was adjudged suitable for closure. Our criteria for establishing readiness for suture were (1) that the nutrition of the patient be definitely improving, (2) that edema had receded from the stoma, (3) *that digital examination reveal an adequate lumen obtainable when the bowel was sutured.* Seventy-two hours were routinely used for preparation. The patient was placed on a low residue, high carbohydrate diet. The proximal and distal loops of the colostomy were irrigated daily, the last irrigation being carried out twenty-four hours before operation. On the first day of preparation 4 Gm. of sulfaguanidine were administered every four hours for six doses, followed by 2 Gm. doses of the same drug every four hours up until four hours before closure. Tincture of camphorated opium was given in 2 dr. doses every four hours for twenty-

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four hours before operation. The bowel was aspirated the evening and morning before the patient was operated upon. Postoperatively, the patient's oral intake of fluid was restricted until flatus was passed, which usually occurred within twenty-four hours after suture. Water balance was maintained by intravenous fluids; gastric suction was used, when indicated. Penicillin and sulfadiazine were both used for seven days after operation. Penicillin was administered by the intramuscular route in doses of 20,000 units every four hours. Five grams of sulfadiazine were given daily. The first twenty-four hours sodium sulfadiazine was given intramuscularly. Thereafter, 1 Gm. was ingested every four hours by the oral route.

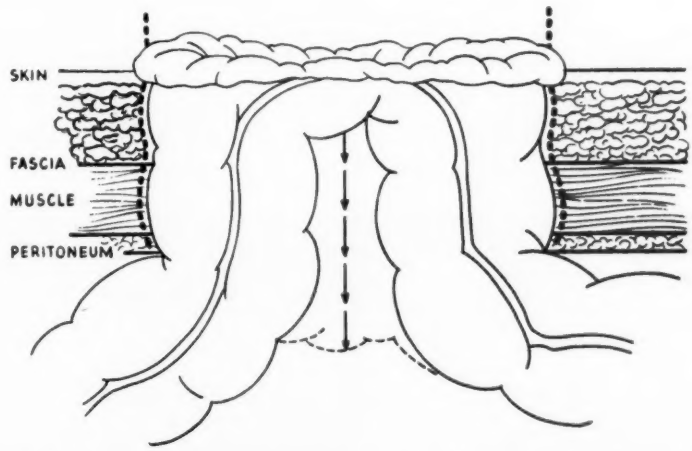


Fig. 1.—Digital examination reveals that no spur is present; bowel can be invaginated into abdomen, securing adequate lumen, as illustrated in Fig. 2. Dotted line represents the incision carried through posterior fascia, not through peritoneum. After closure of the opening in the colon, peritoneum may be opened to eliminate angulation.

## SURGICAL TREATMENT

Colostomies, as we have observed in wounded soldiers, have been established either for diversion of the fecal stream to allow healing of the bowel at a point caudad to the stoma or as a result of exteriorization of the damaged bowel. We have found that, regardless of the purpose for which a colostomy had been established, the findings on *digital examination* can determine the technique of closure best suited for restoration of continuity of the colon for that particular patient. Our cases, based upon information gained from digital examination, fall into four categories. In Fig. 1 is shown the type of colostomy most easily closed. We shall describe our technique in some detail for this type, and then show how it is modified for the other types encountered. In this type of stoma no spur has formed, and when it is examined, gentle pressure with the index finger invaginates the posterior wall of the bowel into the peritoneal cavity; an adequate lumen is readily assured, as demonstrated in Fig. 2. An elliptical incision is made encircling the protruding bowel, and carried down to, but not into, the peritoneal cavity. The colon is thus readily freed from the abdominal wall. The skin is excised from the edges of the bowel, and any rolled-over edge

of bowel, adherent to skin, is carefully dissected free and preserved. The edge of the mucosa is not freshened. Only redundant mucosa is excised. Continuous chromic catgut No. 00 on an atraumatic needle is used for the first row of sutures. These stitches are placed just in the edge of the serosa, so as to invaginate as little bowel as possible consistent with watertight closure. When this row has been placed, sulfanilamide crystals are sprinkled over the suture line, drapes are changed, and gloves washed. A second row of Halsted sutures of fine cotton is placed in the seromuscular layer turning in as little bowel as is consistent with snug closure. *After* the suture line is complete, the peritoneum is opened sufficiently to allow the colon to be placed beneath the fascia without angulation or tension. The abdominal wound is closed in layers by means of interrupted sutures of fine cotton. Sulfanilamide crystals are sprinkled in the wound during closure, a total of 5 Gm. being used in the wound and over the point of suture of the bowel. A drain is used rarely and then only in those patients in whom extensive oozing occurs. In such an instance it is placed only subcutaneously, and allowed to remain only forty-eight hours to evacuate accumulated hematoma.

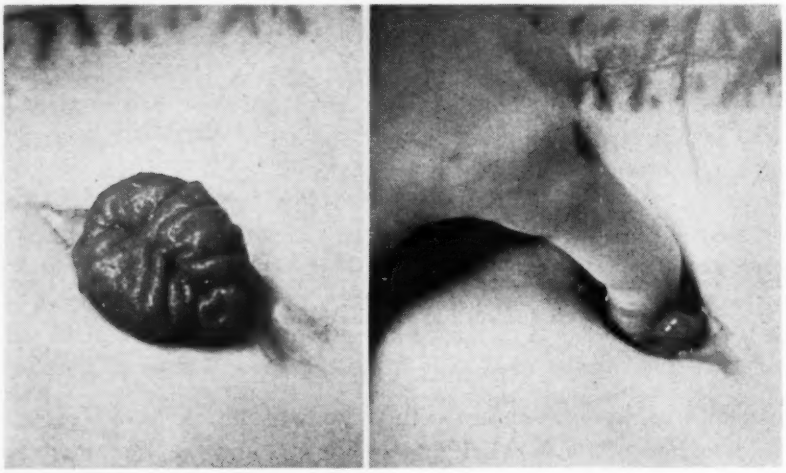

Fig. 2.—Photograph of type colostomy diagramed in Fig. 1. Note that gentle pressure against the posterior wall of the stoma reveals no spur, adequate lumen. Edema has disappeared from the stoma.

If a long, thin spur is present, as illustrated in Fig. 3, crushing clamps are applied in the traditional manner to the spur. When sufficient channel has been produced, and the edema has regressed from the bowel, the colostomy is closed. Usually in this type of case it is found advantageous to open partially the peritoneum before suturing the bowel. This enables the operator to mobilize the limbs of the colostomy, and so obviate tension on the suture line. By leaving the more medial portion of the colon attached to the parietal peritoneum, the closed stoma can be placed in a compartment in the lateral gutter (in the case of a colostomy in either the right or left colon), fairly well sealed off from the general peritoneal cavity. This area of attachment, if properly placed, does not produce tension or angulation at the suture line.

In Fig. 4 is illustrated a condition in which a thick spur is present, but interposed between the two limbs of the spur is a palpable mass. The application of a crushing clamp to such a spur carries with it the risk of grasping a loop of adherent small intestine, thereby producing a troublesome fistula, if not a fatal peritonitis, or the risk of crushing a large mesenteric artery, producing gangrene of a segment of colon. In such cases we have deemed it wise to open the peritoneal cavity liberally, to mobilize the limbs of the colostomy, to free the points of adherence between proximal and distal loops, and then to suture the

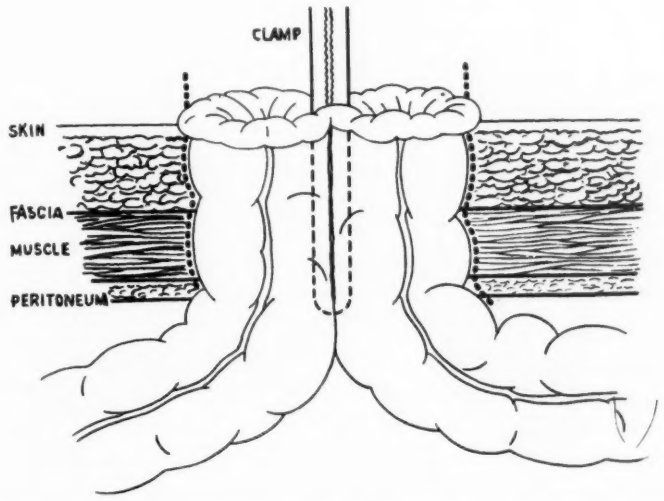


Fig. 3.—A long, thin spur. Crushing clamps are applied to the spur until sufficient channel is produced. Incision, represented by the dotted line, is carried down to the peritoneum, which is partially opened. After closure, the bowel is placed in a compartment of the lateral gutter, partly excluded from the general peritoneal cavity.

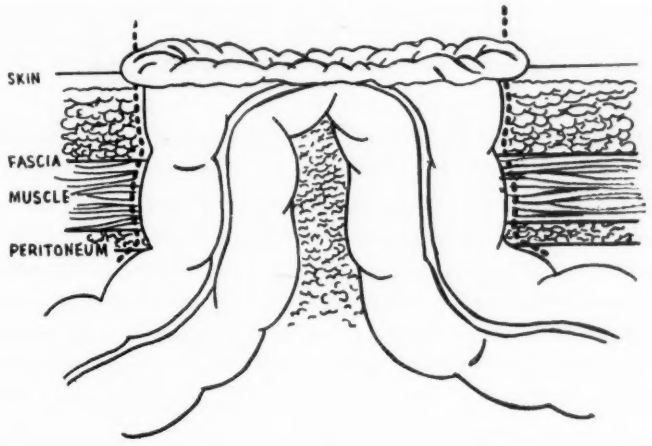


Fig. 4.—Thick spur or palpable mass between limbs of colostomy makes application of clamps to septum dangerous. Incision, represented by dotted line, is carried down into the peritoneal cavity. Limbs of bowel are mobilized and separated. Anterior half, open portion of the colon, is closed as an end-to-end anastomosis.

margins of the stoma in a transverse direction. This is, in effect, applying end-to-end anastomosis to the anterior half of the lumen of the colon. In one patient a palpable mass, thought to be between the two limbs of the colostomy, proved at operation to be a small abscess just lateral to the septum. In this case immediate suture was abandoned, clamps were placed on the spur under direct vision, the peritoneum and fascia sutured, and the skin packed open. Subsequent closure of the colostomy carried out after an interval of two months resulted in primary union.

As illustrated in Fig. 5, a particularly difficult situation is encountered, when a portion of exteriorized bowel retracts or sloughs out beneath the skin. In such cases an abscess forms in the layers of the abdominal wall. With the scarring attendant upon healing of the abscess cavity, the lumen of the colon becomes constricted by a band of scar tissue, and the bowel is adherent to the fascia of the abdominal wall. Palpation reveals no spur, and a very narrow, inadequate lumen. In dealing with the problem presented we have opened the

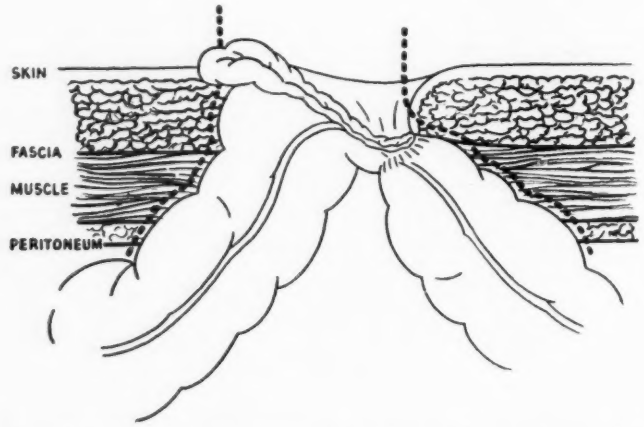


Fig. 5.—One limb of the colostomy has retracted beneath fascia, resulting in abscess with subsequent constriction of the distal loop. Primary incision, represented by dotted line, is carried into the peritoneal cavity. Limbs of the colostomy are mobilized. The scar is excised. Distal lumen is split longitudinally on its antimesenteric border. Suture of the bowel is transverse to its long axis.

peritoneum widely, mobilized the stoma limbs, and freed the scar from the bowel from the adherent fascia. Then we have carefully excised the scar from the wall of the colon and opened the constricted lumen on its antimesenteric border in a longitudinal direction. Suture of the resulting opening in the colon in a transverse direction has resulted in an adequate lumen. As we have observed colostomies in this general hospital, this type of case presents the only problem which might require resection of the stoma and end-to-end suture, and then only if the procedure which has been described fails to give adequate lumen.

Of our twenty-three patients, the peritoneum was opened widely in nine, partially opened in thirteen, and avoided completely in one. Crushing of the spur was employed in fourteen.

Of the twenty-three colostomies closed using the principles of technique and chemotherapy as described, nineteen healed completely by primary union

at fourteen days three developed serous or sanguineous drainage which delayed healing longer than two weeks, and one developed infection in a subcutaneous hematoma. There were no fecal drainage, no deaths, no failure. Two postoperative complications occurred, neither related to the closure. One patient showed signs of small bowel obstruction on the fourth day following closure of the enteric stoma, after having had a normal bowel movement on the third postoperative day. The obstruction proved to be due to an adhesion at the site of the previous small intestinal suture. A severe jaundice, probably of the homologous serum type, revealed itself in the second patient on the fifth postoperative day. Since all our patients were returned to the United States as soon as their wounds healed, follow-up study as to the possible development of late stricture was impossible. All were asymptomatic on discharge from our care.

## DISCUSSION

Since we have no follow-up we cannot speak of end results. Late stricture should be uncommon for three reasons: (1) the immediate postoperative peristaltic action was remarkably smooth; (2) scarring is usually the result of infection, strikingly infrequent in these cases; (3) experience in civilian practice following closure of colostomies in a similar manner revealed that symptoms referable to any suspected narrowing of the lumen of the colon were extremely rare.

Our series, although small, involves most of the problems encountered in colostomy closure. We have adopted the most conservative technique possible for the closure of each colostomy, adapting our technique to suit the type of colostomy with which we were dealing. This policy, together with preoperative, operative, and postoperative chemotherapy, has given us excellent results. If colostomy stomas were all to be resected and continuity re-established by end-to-end suture, as advocated by Keene, we feel sure that the morbidity and mortality would be unnecessarily high. It seems to us that suture of only one-half to two-thirds of the circumference of the large intestine, and that on its antimesenteric border, carries less risk than end-to-end union of the entire circumference. The danger of an inadequate blood supply, of leakage of the suture line at the mesenteric angle, and of an inadequate lumen, all of which are dangers of end-to-end union, are more easily avoided. Even with the newest sulfonamides for enteric use, and the combination of penicillin and oral sulfonamides, there still remain organisms in the intestinal tract, notably some of the nonhemolytic and green-producing streptococci, and members of the aerogenes and proteus groups, which are capable of producing a fatal peritonitis. The presence of these organisms should lead us to prevent the possibility of their free entry into the peritoneal cavity. The peritoneum should be entered in colostomy closure only to prevent tension on the suture line or fixed angulation of the bowel, and to enable accurate closure of the abdominal wall.

The one infection in these cases can be accounted for by technical error. When the skin was sutured the subcutaneous tissue had been insufficiently freed from the fascia. Closure of the skin margins left a potential dead space in which hematoma accumulated and became infected. It should be stressed that serous

or sanguineous drainage occurred in three patients without infection. This drainage might be attributed to the sulfanilamide, but we believe it more logical to give credit to chemotherapy for the sterility of these collections. From the results of our study of secondary suture, it was concluded that utilization of a combination of urea and the sulfonamides, when applied in the abdominal wall, might eliminate some of this serous drainage.

## SUMMARY

1. The various types of colostomies encountered in the wounded in a general hospital in the Army, and the surgical treatment of each type is described.

2. A routine plan of management, preoperatively and postoperatively, involving sulfaguanidine in the preparation of the bowel, local sulfanilamide, and penicillin is described.

3. Twenty-three colostomies were closed. Nineteen healed perfectly, three developed serous or sanguineous drainage, and one developed a small subcutaneous abscess. These was no fecal drainage, no death.

4. Emphasis is laid upon merits of the conservative methods of colostomy closure.

## REFERENCES

1. Coller, F. A., and Vaughan, H. H.: Treatment of Carcinoma of the Colon, Ann. Surg. **121**: 395-408, 1945.
2. Dixon, C. F., and Benson, R. F.: Closure of Colonic Stoma; Improved Results With Combined Succinylsulfathiazole and Sulfathiazole therapy, Ann. Surg. **120**: 562-571, 1944.
3. Keene, C. H.: Colostomies, Bull. U. S. Army M. Dept. (No. 86) 115-117, 1945.
4. Pemberton, J. J., and Black, B.: Delayed Closure of Incision Made at Closure of Colonic Stomas, Surg., Gynec. & Obst. **76**: 385-390, 1943.

# EXPERIMENTS IN ULCERATIVE ENTERITIS

## Failure to Produce It by Mesenteric Lymphatic Obstruction*

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REICHERT and Mathes[1] in 1936 reported that a condition similar to regional ileitis, described by Crohn, Ginzburg, and Oppenheimer,[2] could be produced by lymphatic obstruction. In their hands, intestinal lymphatic obstruction produced in the dog some of the changes seen in regional enteritis in man. They injected the subserosal and the mesenteric lymphatics with irritating or sclerosing materials, with or without the additional injection of bacteria, and observed a thickening of the bowel wall but, unlike regional ileitis in man, no mucosal ulcerations were found. Poppe,[3] using the method of Reichert and Mathes, reported on the actual production of ulcerative colitis in dogs by the obliteration of intestinal lymphatics and lymph nodes, with or without the additional intravenous injection of bacteria. We have been interested in producing intestinal mucosal ulcerations in dogs in order to study the effectiveness of various methods of therapy in this condition. We have repeated Poppe's work and, while we have not achieved his results, we believe we can explain the discrepancy.

### METHODS

We followed Poppe's method of mechanical obliteration of the intestinal lymphatics; the additional intravenous injection of bacteria was not employed, because Poppe observed ulceration of the colonic mucosa without the latter procedure.

Seven dogs were used in our study. Cream was fed to all animals shortly before surgery, so that injections could be made easily into the distended lymphatics. The obliterating agents used were in three instances soricin 2 per cent, and in one instance sodium morrhuate 5 per cent. Bismuth oxychloride was used alone in three dogs and in conjunction with soricin in another dog. The injections were made into the main lymphatics of the radix mesenterii, into lymph nodes, and subserously at various parts of the mesenteric border of the small and large intestinal tract. The main lymphatics in the duodenoileocecal region of one dog were primarily ligated with silk, to be followed later by the injection of soricin. The postoperative course was smooth and uneventful in all dogs except two, which died twelve and twenty-four hours, respectively, after operation without coming out of the anesthesia. The survival periods of the dogs were as follows: twelve, twenty-four, forty-eight, and forty-eight hours, eight days, five weeks and eight and one-half months. Progress of the experi-

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ments was followed in three dogs by reoperation, during which time further injections were made. All animals eventually were studied at autopsy.

## RESULTS

Severe inflammatory reactions with redness and swelling of the entire thickness of the bowel were seen in the four dogs autopsied within forty-eight hours. Three of these dogs had been injected with bismuth oxychloride, the other one with sodium morrhuate. The shorter the time interval between injection and inspection, the greater was the gross inflammatory appearance and the exudation of serosanguineous fluid into the peritoneal cavity. Only in those of our experimental animals that were autopsied or reoperated upon one week or later after injection, no free fluid was found in the peritoneal cavity. This is opposed to the findings of Reichert and Mathes, who did not find free peritoneal fluid in any experiment. There was some redness and swelling in the bowel wall in the dog sacrificed in eight days, but here essentially was seen a loss of transparency of the mesenteric surfaces. In only one instance out of the seven experiments was there ulceration of the mucosa. This occurred in the cecum and it was apparent that the etiologic factor was an arterial thrombosis and not lymphatic obstruction. This was verified by the histologic picture, which showed a hemorrhagic infarct. In all instances was the bowel wall thickened, and the longer the time interval became between the injection and inspection, the less inflammatory and the more fibrotic became the bowel wall changes. Dry, sticky, easily separated adhesions were present in the dogs which survived five weeks to eight and one-half months. In no instance did the dogs develop a bloody diarrhea, constipation, or vomiting. This is opposed to Poppe's observation of severe bloody vomiting and of severe bloody diarrheas, some of the animals dying in hemorrhagic shock.

## DISCUSSION

We did not obtain chronic ulcerative colitis in the dog, our results being at marked variance with those reported by Poppe. Mucosal changes were observed only during the acute stage following the injections. They were a part of the generalized inflammatory reaction involving the entire bowel wall, mesentery, and contiguous serous surfaces, and were not ulcerative. Later, as a chronic condition developed, the acute inflammatory reaction subsided and chronic fibrotic changes took its place. We are in doubt as to whether these final fibrotic changes were not a late result of the inflammatory reaction with reduced circulation of blood produced by the agents used, rather than the result of lymphatic obstruction per se. In our animals reoperated upon, lymphatics and lymph ducts filled with white chyle were observed in the regions that had been injected previously. This may mean that it is hardly possible to obstruct all or most lymphatics even with massive injections such as we used. The lymphatic system is more spread out and ramified than any one of the other vascular systems. Our negative results of mucosal ulcerations confirm those of Reichert and Mathes, who also reported no mucosal defects, only a thickening of the bowel. Poppe's positive results may have been due to actual thrombotic obstruction of

arteries and veins. Our results were so uniform that we believe that in spite of the relatively small series of seven dogs our conclusions are justified.

We feel that the problem of producing ulcerative enteritis in the dog experimentally by lymphatic obstruction is not solved.

## SUMMARY

Attempts to produce ulcerative enteritis in the dog by partial obstruction of intestinal lymphatic flow failed. Bismuth oxychloride, soricin, and sodium morrhuate injected into the lymphatics of the intestines were used as obstructing or sclerosing agents. Acute inflammatory changes in the entire thickness of the bowel wall were seen early after injection, but this receded and only thickening of the bowel wall was seen after several weeks to eight one-half months. The mucosa was intact in all instances except in one where an ulcer was overlying a thrombosed cecal artery. Poppe's findings of ulcerative colitis in the dog may have been due to vascular thrombosis rather than to lymphatic obstruction.

## REFERENCES

1. Reichert, F. L., and Mathes, M. E.: Experimental Lymphedema of the Intestinal Tract and Its Relation to Regional Cicatrizing Enteritis, Ann. Surg. **104**: 601, 1936.
2. Crohn, B. B., Ginzburg, L., and Oppenheimer, G. D.: Regional Ileitis—a Pathologic and Clinical Entity, J. A. M. A. **99**: 1323, 1932.
3. Poppe, J. K.: Reproduction of Ulcerative Colitis in Dogs, Arch. Surg. **43**: 551, 1941.

# THE SPLIT-THICKNESS SKIN GRAFT AS A COVERING FOLLOWING REMOVAL OF A FINGERNAIL

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REGENERATION of an intact fingernail depends on the complete integrity of its radix. When the radix has been damaged the injury is reflected in a faulty nail which may be thicker or thinner than normal, cracked, brittle, flaky, and frequently an excrescence which may be a thorough nuisance to its owner. Such a nail is far better removed and its regrowth prevented by complete destruction of the diseased or injured radix. Simple removal of the nail is not enough; the entire radix must be removed.

It is quite possible that the use of split-skin grafts in this connection has previously been described. However, I have been unable to find any previous reference to it. Removal of the radix destroys all nail growth and it becomes necessary to cover the defect. The application of a split graft on the nail bed meets the situation admirably. The graft really resembles a fingernail and the loss of the nail is apparent only on rather close inspection. This is one site where the difference in color and texture of the graft and that of the surrounding skin is an advantage.

Herewith are illustrated two examples of split grafts which have made very satisfactory substitutes for thumbnails. In one case, on the hand of a dentist, excessive roentgen irradiation had injured both the matrix and the radix of the

Fig. 1.

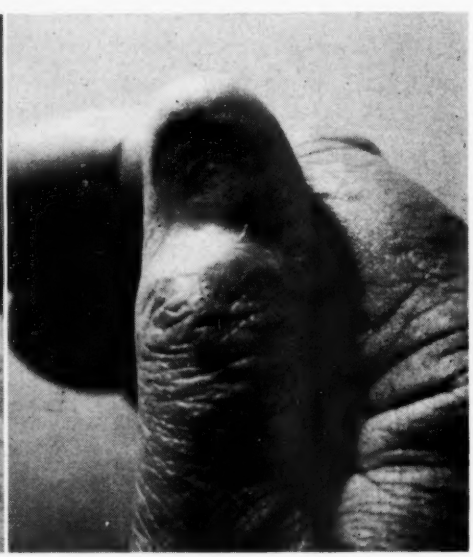

Fig. 2.

Fig. 1.—Distal joint of thumb injured by excessive exposure to x-ray.

Fig. 2.—A split graft used to cover the defect on the joint of the thumb after removal of damaged nail and radix.

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Fig. 3.

Fig. 4.

Fig. 3.—Distal joint of thumb showing the point of exquisite tenderness.

Fig. 4.—The thumb shown in Fig. 3, after removal of the nail and the radix in which was found a glomus tumor. The bed of the nail has been covered by a split graft.

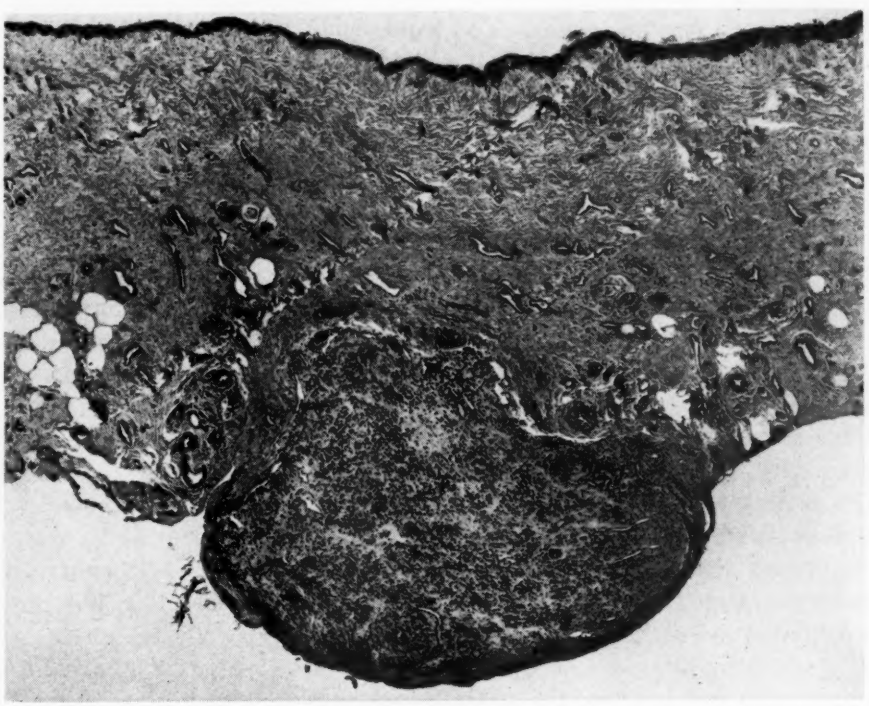

Fig. 5.—Section through the radix of the thumbnail shown in Fig. 3, showing the small glomus tumor which was found on the undersurface of the radix.

nail and brought about the condition shown in Fig. 1. The nail and the radix were removed and the defect covered with a split graft taken from the thigh. In the second case the patient complained of an exquisitely painful point just at the base of the thumbnail. His description of the pain was typical of that caused by a glomus tumor. It was decided to remove the nail and since the tumor would undoubtedly be found in the radix to remove that also. Roentgenographs of the terminal phalynx had shown no involvement of the bone. After the nail was removed and a flap of skin turned back at the base of the nail, the radix showed only a faint point of redness on its outer surface. The radix was carefully dissected away from the surface of the bone and the glomus tumor was seen as a 2 mm. nodule standing out from the undersurface. The radix was removed and the defect covered as in the first case. Both the subsequent appearance and function have been very satisfactory to the individuals concerned.

Application of the grafts in this locality is not as simple as elsewhere. The fixation is difficult because of hemorrhage. Possibly fibrin fixation might help but I have not used it. Hemorrhage may be controlled by two or three very fine catgut ligatures, by pressure, and by topical thrombin. The graft may be sutured around the margin of the defect with continuous nylon and several interrupted nylon sutures tied over a small piece of xeroform gauze placed directly on the graft. Considerable comfort may be gained by using a small curved metal splint for the ball of the thumb and exerting pressure on the graft by bandaging over a fine-grade marine sponge. The hand should be kept elevated on pillows for at least twenty-four hours and in a sling during the remainder of the healing period. The aftercare is as usual for this type of graft.

# Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

## ACTINOMYCOSIS

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### THE TREATMENT OF EXTENSIVE ACTINOMYCOSIS

OUR interest in the problem of the treatment of extensive actinomycosis was aroused by a case of advanced abdominal actinomycosis occurring in a young girl. Over a period of several months, the progress of the disease was arrested, the patient rehabilitated to a normal life, and probably cured. A review of the hospital records revealed that although the results in the treatment of mild or early cases of actinomycosis using a variety of therapeutic agents were good, the treatment of advanced cases of actinomycosis was uniformly unsuccessful. With this in mind, the case records have been carefully examined and compared, and a review of the literature has been made. The collected information has been used as a basis for an evaluation of the treatment of extensive actinomycosis.

*History.*—In 1877, Bollinger[16] reported that he had found branching mycelia in the material from a diseased jawbone of a cow. He considered them to be the causative agents of this condition. This organism was named Actinomyces or the "ray fungus" by Harz.[67] At this same time Israel[82] described the organism as found in human autopsy material. The disease was first recognized clinically by Ponfick[138] in 1879. In 1885, Israel[83] reviewed thirty-eight cases of actinomycosis and clearly defined the disease as a clinical entity. The first careful studies of the etiology and pathogeneses of actinomycosis were carried out by Bostroem[17] and by Wolff and Israel.[182]

*Etiology.*—The organisms causing actinomycosis belong to the Actinomycetes. These microorganisms are gram positive and are characterized by the formation of a mycelium or network of branched filaments. Waksman[172] considered them to be an independent group of organisms closely related to the true bacteria which had developed a funguslike form of growth. The organisms of this group are closely related to the tubercle bacillus, the leprosy bacillus, and the diphtheroids.[10, 169] The members of this group live in the soil, on grains and grasses, and in water.[71] Several species are pathogenic for plants; for example, potato scab. Only a very small number of these organisms are pathogenic for man and animals.

On the basis of their oxygen requirements, the actinomyces may be divided into an aerobic group and an anaerobic or microaerophilic group. The aerobic

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group is almost entirely composed of harmless vegetable saprophytes. Naeslund,[127] in a survey of 500 different strains of aerobic actinomyces, found only two which produced actinomycosis in experimental animals. The anaerobic or microaerophilic group, on the other hand, is composed almost entirely of pathogens. Using their oxygen requirements as a basis of classification. Waksman and Henrici[173] have arranged the pathogenic actinomyces into the genus Actinomyces, which contains the microaerophilic and anaerobic pathogens, and the genus Nocardia, which contains the aerobic pathogens. Organisms of both genera will produce actinomycosis in man. (Slack,[159] Rosebury and associates,[149] Lord,[100, 101] and Naeslund.[127])

*Pathogenesis.*—There have been two main concepts of the pathogenesis of actinomycosis. Bostroem[17] believed that actinomycosis was due to an infection with aerobic actinomyces found in the environment and, therefore, was an exogenous infection. Wolff and Israel[182] believed that the disease was caused by anaerobic actinomyces, which could not be readily isolated from the environment, and considered the disease to be endogenous in origin.

Bostroem held that human actinomycosis was associated with bovine actinomycosis and that human infections occurred either directly by contact with diseased animals or indirectly through the mediation of contaminated vegetable fomites, that is, straws, grasses, etc. For many years these were considered to be the most important modes of infection and clinicians laid stress upon a history of contact with animals with "lumpy jaw," a habit of chewing straw or stalks, and a rural habitat. Naeslund[127] and Erikson[50] have shown that only a very small number of the aerobic actinomyces found in nature are pathogenic. Aerobic actinomyces have been isolated from the mouth.[13] As will be shown later, a history of contact with so-called actinomycotic animals is of little importance unless the exact nature of the disease in animals is known. Analysis of reported cases has shown actinomycosis to be as common in cities as in rural areas. Aerobic infections occasionally occur as attested by the reports of Naeslund,[127] Erikson,[50] and Biggart.[14] Benbow, Smith, and Grimson,[9] reporting on cases of pulmonary actinomycosis due to aerobic organisms, estimate that 10 per cent of pulmonary actinomycosis is caused by aerobic infection. Naeslund[127] believed that aerobic infections were most common in the chest or in cases with metastatic foci. It must be concluded, however, that exogenous infections with aerobic actinomyces (Nocardia) form only a small minority of actinomycotic infections.

By far the largest share of actinomycosis is produced by anaerobic or microaerophilic actinomyces (Actinomyces)[51] and may be considered as endogenous infections, the concept promulgated by Wolff and Israel. It was Naeslund's impression that the anaerobic actinomyces were associated with actinomycosis of the gastrointestinal tract and tissues in juxtaposition to the gastrointestinal tract. The normal habitat of the anaerobic actinomyces is in the oral cavity. Lord,[100, 101] Emmons,[45-47] and Slack[159] have isolated pathogenic actinomyces from the tonsils. Davis,[33] however, has called attention to the fact that all tonsillar granules are not actinomycotic. Actinomyces have been isolated from pyorrhea pus, dental scum, salivary calculi, and the contents of

carious teeth by Slack,[159] Lord and Trevett,[102] Rosebury and associates,[149] and Sullivan and Goldsworthy.[166] Using these organisms, the pathologic picture of actinomycosis has been produced in animals by Slack,[159] Rosebury and associates,[149] Lord,[101] and Naeslund.[127]

The relationship of dental caries to actinomycosis was first noted by Lord,[100, 101] who stated that under certain conditions persons with carious teeth were liable to develop actinomycosis. Axhausen[3] and Sullivan and Goldsworthy[166] have noted that the acute form of facial actinomycosis not infrequently follows exodontia. Israel reported a case (cited by Naeslund) in which pulmonary actinomycosis followed the aspiration of a tooth. At autopsy, the center of infection was found to contain fragments of the tooth. Colebrook[28] and Robinson[147] have reported cases of actinomycosis of the hand and arm following human bites. In Table I is illustrated the coincidence of dental sepsis in thirty-nine cases of actinomycosis which we are reporting here.

TABLE I. COINCIDENCE OF ORAL SEPSIS WITH ACTINOMYCOSIS

| TYPE | NUMBER OF CASES | ORAL SEPSIS PRESENT |
|---|---|---|
| Cervicofacial | 16 | 15 |
| Lingual | 2 | 2 |
| Abdominal | 14 | 6 |
| Thoracic | 7 | 2 |

Minor trauma, inflammation associated with root abscesses or exodontia, may afford the opportunity for the actinomyces to become invasive. The actinomyces in the oral cavity are probably carried into the gastrointestinal tract by the act of deglutition. From this point, we know nothing of their progress through the intestinal tract. It may be inferred from clinical observations, however, that in some cases the organisms are retained in the cecum or in diverticula in the colon. Actinomyces from the oral cavity may gain admittance to the tracheobronchial tree by aspiration. The aerobic actinomyces, occurring widely in the environment, have rarely been reported in the mouth.[13, 50] They may reach the lungs through the respiratory tract. The pathogenesis of aerobic infections is unknown.

Axhausen[3] has stressed the importance of pyogenic cocci in initiating cervicofacial actinomycosis. Wright[185] believed that only a small number of actinomycotic infections were pure infections with specific organisms. Naeslund[127] felt that mixed infections were of significance only in producing a more rapid spread of the infection and a greater inflammatory reaction by the tissue. Wangensteen[178] believed that the concomitant bacterial invaders, by reducing the oxygen potential of the tissue, aided in producing the required anaerobiasis for the growth of the Actinomyces. The role of specific bacterial synergists is unknown. Although *Actinobacillus actinomycetem comitans*[5] is found only in the lesions of actinomycosis, the disease has been produced in animals with pure cultures of the actinomyces.

The importance of tissue sensitivity in relation to the production of actinomycosis was pointed out by Henrici and his group.[116] They were able to produce actinomycosis in animals by repeated inoculations with small num-

ber of actinomyces over a period of weeks. The possibility exists that a patient harboring pathogenic actinomyces in the oral cavity may by the process of repeated exposure develop sufficient sensitivity to the organisms or their products so that an allergic reaction itself might provoke an inflammatory reaction of sufficient intensity to allow the actinomyces to gain a foothold in the tissue.

The actinomyces themselves are not actively motile. Extension of the infection occurs through the activity of the macrophages which carry the filaments out into the surrounding tissue.[18] The inference may be drawn that an inflammatory reaction must be present before an actinomycotic infection can become established. In cervicofacial infections, this inflammatory nidus is probably furnished by the presence of dental sepsis or exodontia. The frequent association of abdominal actinomycosis with appendicitis and diverticulitis indicates an inflammatory mechanism by which the organisms may gain access to the retroperitoneal tissues. The frequency of mild inflammatory processes in the chest can give ample opportunity for the infection to become established.

*Pathology.*—Histologically the lesions of actinomycosis represent a chronic suppurative process. The organisms occur either as dispersed mycelia or collected in the characteristic granules. The granules are composed of radially arranged masses of branching mycelia. In sections stained with the Gram stain, the granules have a central portion consisting of mycelial threads which are Gram positive and a peripheral zone of mycelial clubs which are Gram negative. The granules are surrounded by a collection of polymorphonuclear leucocytes, small round cells, and mononuclear cells. On the periphery of the cellular exudate there is a marked fibroblastic reaction. When granules cannot be demonstrated, the infected tissue shows only a nonspecific type of chronic inflammation.

The incubation period of actinomycosis cannot be determined with accuracy. The infection begins in the subcutaneous, submucous, or subperitoneal connective tissue as a small area of brawny or "wooden" induration. Following the stage of induration there is a progressive erosion of the connective tissue. The overlying skin breaks down with the formation of multiple sinuses which drain a seropurulent discharge containing the characteristic sulfur granules. Spread through the blood stream is uncommon, but a lesion may rupture into a vessel and give rise to metastatic foci in distant organs. Actinomyces have been obtained by Northrop and Crowley[133] in pure culture from the blood stream immediately following exodontia. Extension through the lymphatics occurs only rarely and the entire lymphatic system enjoys a surprising degree of immunity. The infection tends to spread beneath, but not across, epithelial or endothelial barriers. The peritoneum is quite resistant to attack; large masses of actinomycotic tissue may form behind the peritoneum without perforating into the abdominal cavity. The pleura does not have the same powers of resistance and is commonly involved in thoracic actinomycosis.

*Clinical Aspect.*—Actinomycosis is a chronic disease affecting man and animals characterized by the formation of granulomatous tumors usually associated with multiple fistulas to the overlying skin, which drain a seropurulent discharge containing yellow granules. Actinomycotic lesions have been reported from all parts of the body but are commonly situated in the cervicofacial, thoracic, and abdominal regions (see Table II).

TABLE II. THE SITUATION OF ACTINOMYCOTIC LESIONS

| AUTHOR | NUMBER OF CASES | CERVICO-FACIAL (%) | THORACIC (%) | ABDOMINAL (%) | MISCELLANEOUS* (%) |
|---|---|---|---|---|---|
| Sanford and Voelker[151] | 670 | 60 | 14 | 18 | 8 |
| Cope[30] | 1,330 | 57 | 15 | 22 | 5 |

*For a discussion of these cases, see Cope[30] and Orr.[120]

The incidence of actinomycosis is difficult to estimate. In the years 1930 to 1936, the average number of reported deaths due to the disease in the United States was just over sixty. The number of reported cases has been rising slowly during the past twenty-five years due to more accurate diagnosis. Cope[31] believed that the number of reported cases depended upon the acumen of the diagnosticians, an opinion supported by the work of Sanford.[150] The world-wide distribution of actinomycosis is shown in Fig. 1. In the United States, the greater number of reported cases have come from the North Central States. Sanford, however, believed that the increased incidence in this region was apparent rather than real and was due to more accurate diagnosis. Cope and Sanford were unable to find any increased incidence of the disease in rural areas. Occupation seemed to be of no significance. In an analysis of 670 cases of actinomycosis, Sanford and Voelker[151] found that the median age incidence fell between 20 and 30 years. Eighty per cent of the patients were men.

The clinical picture of actinomycosis in man and animals may be produced by three different microorganisms: some actinomyces (actinomycosis), a staphylococcus (botryomycosis),[41, 112] and an actinobacillus (actinobacillosis).[99] Botryomycosis and actinobacillosis occur infrequently in man, but are common in animals.[111] Actinomycosis occurs frequently in both man and animals.

The differential diagnosis of these diseases in animals is important as it affects the theory of the etiology and the rationale of the treatment of actinomycosis in man. The studies of Magnusson,[111] Griffith,[61] and Shahan and Davis[158] indicate that only a fraction of all of the animals with a clinical diagnosis of actinomycosis suffer from this disease. It follows from this that a history of contact with so-called actinomycotic animals is of little significance in human actinomycosis unless the nature of the disease in the animal is conclusively determined. Simple gram stains of the granules found in these conditions may be used to differentiate them accurately and a positive diagnosis of actinomycosis can be made from a single typical granule.

The importance of cultural methods in the diagnosis of actinomycosis lies in the differentiation of the aerobic actinomyces (Nocardia) from the micro-

aerophilic or anaerobic actinomyces (Actinomyces). Successful isolation of the organisms is quite difficult under any circumstances and in old chronic lesions it is almost impossible to separate the primary organisms from the

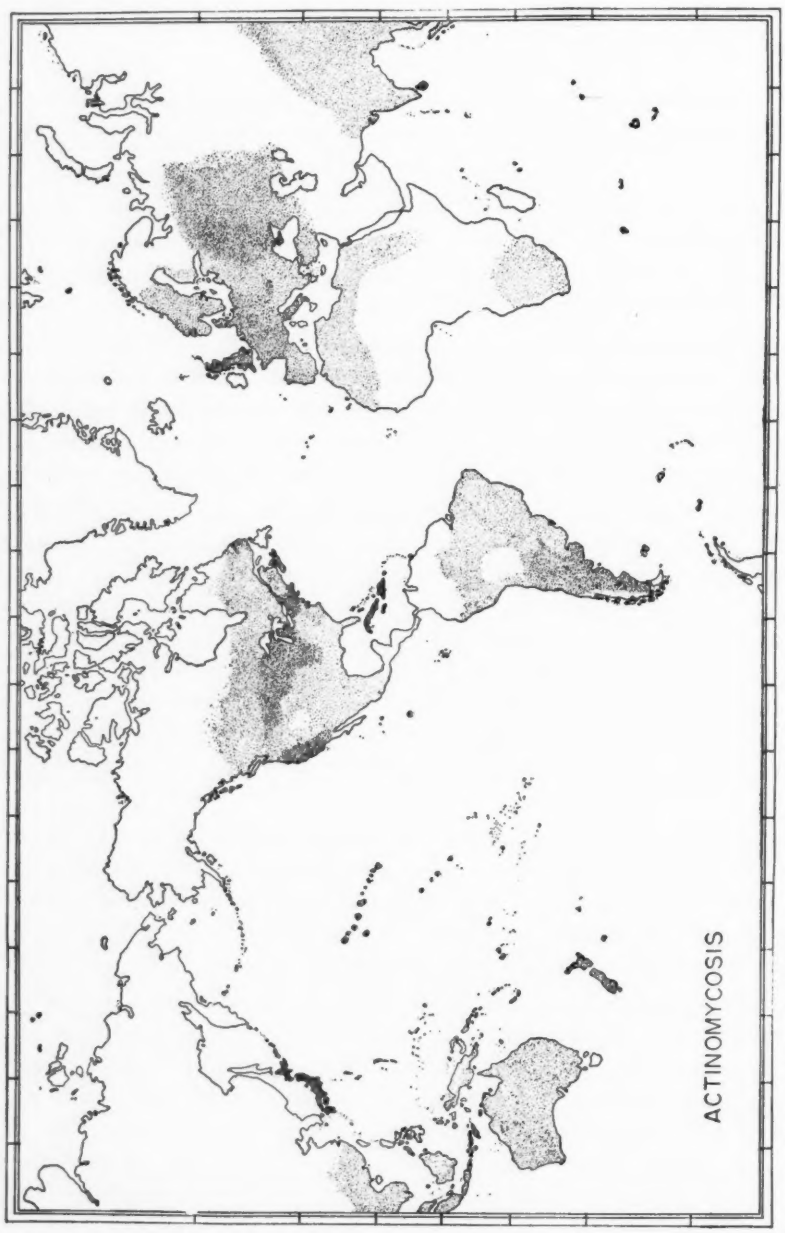


Fig. 1.—Geographic distribution of actinomycosis. (From the Manual of Clinical Mycology, Philadelphia, 1945, W. B. Saunders Company.)

host of secondary invaders. Attempts at culturing the organisms are most successful in recent lesions which are being incised for the first time. The cultural techniques used for the isolation of actinomyces have recently been reviewed in a publication of the National Research Council.[113]

The classic picture of cervicofacial actinomycosis is the slow onset of swelling and induration with sinus formation although Axhausen[3] has pointed out the importance of recognizing the acute forms of the disease. The mortality in cervicofacial actinomycosis is due to the involvement of vital tissue by extension from the original site of infection. In order to determine the prognosis of cervicofacial infections and to evaluate the treatment more accurately, we have divided them into three types, depending upon the degree of localization or extension at the time treatment is instituted. Type 1, a circumscribed abscess or area of induration without sinuses; Type 2, lesions with sinuses but not invading vital structures; Type 3, lesions extending into the orbit, sinuses, spine, or mediastinum. The prognosis with the first two types is usually good. Lesions of the third type usually terminate with an actinomycotic meningitis or with thoracic involvement.

Thoracic actinomycosis may be primary or secondary. Secondary involvement may be due to extension from the cervical region or from the abdomen. In these cases the primary lesions usually indicate the diagnosis. Primary thoracic actinomycosis presents much more of a diagnostic problem, being similar in many ways to other forms of chronic pulmonary suppuration. Naussac[128] has classified pulmonary actinomycosis into three anatomic divisions: (1) bronchoactinomycosis, (2) pleuropneumoactinomycosis; and (3) pneumoactinomycosis. Fever, cough, and expectoration are common to all types. Hemoptysis is rare. Depending upon the type of infection, the symptoms may be predominantly those associated with a bronchitis, a pulmonary effusion, an empyema, or a pulmonary consolidation. The diagnosis can be made by demonstrating sulfur granules in the sputum or pleural fluid. Periostitis of the ribs associated with nonspecific changes in the lung may lead to the roentgenologic diagnosis.[93] Empyema necessitatis is frequently the presenting symptom in thoracic actinomycosis.

Abdominal actinomycosis shows a predilection for the right lower quadrant and frequently follows operations for acute appendicitis or drainage of abscesses in this region. Occasionally it is associated with diverticulitis of the colon. Any draining sinus on the abdominal wall should be carefully examined to exclude actinomycosis. The presence of a fecal fistula in a patient with abdominal actinomycosis indicates a grave prognosis. In order to make a more accurate estimate of the prognosis of abdominal actinomycosis, Morton[123] has divided them into three groups: (1) those resembling acute appendicitis with a residual sinus tract, (2) those presentng a mass in the right lower quadrant without signs of obstruction, and (3) those associated with psoas spasm or a flexed thigh.

*Treatment.*—The history of the treatment of actinomycosis simulates that of all infectious diseases. Groping through the available therapeutic armamentarium following current fads, physicians have employed surgery, chemotherapy, vaccines, irradiation, and latterly the current chemotherapeutic panaceas, the sulfonamides, and penicillin, in an effort to cure the disease. The popularity of the various forms of treatment has waxed and waned. The results of treat-

ment have been variable. The number of remedies attests to the lack of uniform success with any one of them. A review of the literature reveals many ambitious claims for all. Because the chronicity of the disease made it possible for many forms of treatment to be used successively or simultaneously, the evaluation of any single therapeutic agent is difficult. The lesions have only rarely been classified as to extent, making the results of treatment difficult to compare. In general, the fact evolves that cervicofacial and other circumscribed actinomycotic lesions have been amenable to treatment with the majority of the methods tried. This is in contrast to the relative incurability of the abdominal disease and with the exception of isolated cases, the almost inevitable mortality in thoracic actinomycosis.

A list of the larger series of cases of actinomycosis treated by various methods has been gleaned from the literature. These include the majority of the important papers dealing with the treatment of actinomycosis, but the list is by no means complete. Combinations of treatment have been used by most authors reporting. Adjuvant potassium iodide is the most common. Each author, however, relied mainly on one form of therapy and considered the success of his treatment to be due to that agent. A summary of authors, types of cases, and results has been appended to the discussion of each form of therapy.

*Surgery.*—Incision into and drainage of collections of pus is one of the most ancient surgical remedies. No doubt, long before actinomycosis was described as an entity surgeons were draining the abcesses associated with the disease. The exact history of the establishment of the surgical treatment of actinomycosis is difficult to trace. The search for other methods of treatment in the disease early in its history suggests that the results of incision and drainage of actinomycotic lesions were not attended by favorable results. The proper effective surgical treatment gradually evolved from the experience gathered in the treatment of the disease. As far as we can determine, the principles were first clearly stated in 1905 by Waring,[179] a British surgeon. This man cured four of seven cases of abdominal actinomycosis originating in the right lower quadrant by means of surgery and adjuvant potassium iodide therapy. He wrote, "The limits of surgery appear to be incision, evacuation, scraping, draining of abscesses immediately they can be diagnosed, and afterwards repeated irrigation with an antiseptic solution, with iodine or better, with a solution of peroxide of hydrogen. The latter chemical agent appears to be the most effective agent in arresting the local growth of the parasite." This paper established the proper technique for the surgical treatment of actinomycosis. The factor of meticulous local wound hygiene was emphasized by Smith,[161] and we feel that it is exceedingly important. Colebrook[29] in 1921 amplified Waring's principles in his paper on vaccine therapy, and he prophesied the possibility of success in extensive thoracic and abdominal actinomycosis with radical surgical management. Brickner[19] of New York reported in 1925 that he had cured five patients suffering with severe low abdominal and pelvic actinomycosis by means of radical incision, excision, and curettage followed by oral potassium iodide and the local application of Lugol's solution.

Wangensteen, after observing many patients with actinomycosis, unsuccessfully treated with conservative methods, turned to surgery. In 1936, reporting his success in the surgical treatment of actinomycosis, he[178] emphasized that radical surgery per se is the sine qua non of the treatment of extensive actinomycosis. He concluded: "The most direct agency in the treatment of actinomycosis is surgery. The rationale of the surgical treatment lies in the fact that the infection is essentially an anaerobic one. Removal of the dead tissue, which is poorly oxygenated and is in consequence an excellent culture medium, will usually terminate the disease." He relied mainly on the removal of dead tissue by repeated curettage. He considered the prognosis of advanced cases of abdominal and thoracic actinomycosis to be poor.

A tabulation of the results of the surgical treatment of actinomycosis will be found in Table III.

TABLE III. RESULTS OF SURGICAL TREATMENT OF ACTINOMYCOSIS

| AUTHOR | DATE | THERAPY | TYPES OF CASES AND RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
| | | | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Gangolphe and Duplant[57] | 1897 | S, P | | | | | | | | | | | 1 | | 1 | | |
| Bell[8] | 1905 | S, P, Si | 3 | 3 | | | | 1 | | | 1 | | 4 | 1 | | 3 | |
| Choyce[24] | 1910 | S, P | | | | | | | | | | | 1 | | 1 | | |
| McKenty[109] | 1913 | S, P | 19 | 15 | | 0 | 4 | 2 | | | 2 | | 11 | 2 | | 9 | |
| Cope[30] | 1915 | S, P | 6 | 4 | 2 | | | 3 | | | 3 | | 2 | | 1 | 1 | |
| Ramstad[142] | 1916 | S, P | 4 | 3 | | 0 | 1 | 1 | | | | 1 | 1 | | | 1 | |
| Ochsner[134] | 1917 | S, P | | | | | | | | | | | 1 | | 1 | | |
| McCallem[106] | 1919 | S, P | 4 | 1 | 1 | 2(?) | | | | | | | 2 | 1 | | | 1 |
| Matz[117] | 1922 | S | | | | | | | | | | | 7 | 4 | | 3 | |
| Brockman[20] | 1922 | S, P, V | | | | | | | | | | | 4 | | | 4 | |
| Brickner[19] | 1925 | ---- | | | | | | | | | | | 5 | 5 | | | |
| Smith[161] | 1930 | S | | | | | | | | | | | 7 | | 5 | 2 | |
| Wangensteen[177] | 1932 | S, P | | | | | | 1 | 1 | | | | | | | | |
| Pope[139] | 1935 | S, X* | 10 | 10 | | | | 1 | | | 1 | | 2 | | | 2 | |
| Ellis[44] | 1935 | S | | | | | | 2 | | 1 | 1 | | 3 | | | 3 | |
| Bisgard[15] | 1938 | S, P, X | | | | | | 2 | 2 | | | | | | | | |
| Schmitt and Olson[155] | 1941 | ? | | | | | | 2 | | | 1 | 1 | | | | | |
| Randall[144] | 1942 | S | 16 | 12 | | 1 | 3 | | | | | | | | | | |
| Ziskin et al.[187] | ---- | S, P, X | 17 | 11 | 4 | 2 | | 4 | | 1 | 3 | | 5 | 1 | | 4 | |
| U. of Minnesota Surgical Dept.† | ---- | S, P, X, Sn | 17 | 10 | 3 | 4 | | 7 | | | 7 | | 14 | 1 | | 13 | |
| Totals | | | 96 | 69 | 10 | 9 | 8 | 26 | 3 | 2 | 19 | 2 | 70 | 15 | 9 | 45 | 1 |

S, Surgery.
P, Potassium iodide.
X, X-ray.
Sn, Sulfonamide.
O, Number of cases.
C, Number of patients cured.
I, Number of patients improved.
D, Number of deaths.
V, Vaccine.
N, No follow-up.
Si, Silver nitrate.

*X-ray therapy was added to surgical treatment in three cases of Pope's series.
†Includes cases reported by Wangensteen[177, 178] and Randall.[143]

*Potassium Iodide.*—Potassium iodide was introduced empirically by Thomassen[168] in 1885 for the treatment of lingual actinomycosis of cattle. Nocard[131] championed the drug and stimulated its introduction in the treatment of human actinomycosis by Itterson and Netter[84] in the same year. In spite of the optimistic recommendations and the success attending the use of potassium iodide in other granulomatous diseases (for example syphilitic gummas), its

therapeutic ineffectualness in both bovine and human actinomycosis was soon obvious. Harbitz and Grondahl[64] and later Henrici[72] found in in vitro studies luxuriant growth of actinomyces in media containing 2 per cent potassium iodide. Clinical experience fortified by these studies established the inutility of potassium iodide therapy in actinomycosis. An interesting sidelight on the history of potassium iodide therapy in actinomycosis is related to Thomassen's success with what he thought was lingual actinomycosis. As first described by Lignieres and Spitz[99] and shown by Griffith[61] and others,[111, 158] granulomatous lesions of the bovine tongue are usually due to actinobacillosis which is specifically amenable to potassium iodide therapy. The universal application of potassium iodide to human actinomycosis is an example of a world-wide medical hebetude resulting from Thomassen's ignorance of the bacteriology of the disease he treated. At the present time, enlightened clinicians share the opinion of Colebrook,[29] Jungling,[87] and Wangensteen[178] that reliance upon potassium iodide for the treatment of actinomycosis is not warranted and that at the present time no indications for its use exist.

*Copper Sulfate.*—Copper sulfate was introduced by Bevan[12] in 1905 for the treatment of actinomycosis as an adjuvant to surgical drainage. He was influenced by the experience of agriculturists who had found this chemical an effective fungicide for grains contaminated with molds. The drug was administered orally and the sinus tracts were irrigated with a 1 per cent solution. Several authors used copper sulfate in their shotgun approach to the treatment of actinomycosis. Von Baracz[170] treated successfully thirty out of thirty-six patients with actinomycosis by the parenchymatous injection of copper sulfate solution. His cured patients had cervicofacial disease, while two with abdominal disease died and four were still under treatment at the time of his report.

Other chemotherapeutic methods employing the arsenicals, methylene blue, and iodine- iontophoresis are scattered through the literature, but are not of sufficient importance to warrant detailed discussion.

*X-ray and Radium Irradiation.*—The radiation therapy of actinomycosis was introduced by Harsha[66] in 1904. At the Chicago Surgical Society, he reported a case of cervicofacial actinomycosis which was cured by means of combined potassium iodide and x-ray irradiation. By 1905 Bevan[11] had treated six patients with irradiation. In 1916, Heyerdahl[76] of Oslo reported a cervicofacial case cured by radium emanations and by 1919 had reported success in six cases.[77] An incomplete review of the literature is summarized in Table IV. The number of authors reporting attests to the popularity of this method of treatment.

Employed initially with potassium iodide, it was thought that the x-rays caused the release of nascent iodine which killed the actinomyces in the lesions. Jungling[87] and others have shown that irradiation is effective in the absence of adjuvant potassium iodide. Kleesattel[94] subjected pure cultures of pathogenic actinomyces to irradiation. He found that they tolerated up to ten erythema

TABLE IV. RESULTS WITH RADIATION THERAPY OF ACTINOMYCOSIS

| AUTHOR | DATE | THERAPY | TYPES OF CASES AND RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
| | | | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Harsha[66] | 1904 | X, P | 1 | 1 | | | | | | | | | | | | | |
| Bevan[11] | 1905 | X, S, P | 1 | 1 | | | | 1 | | 1 | | | 4 | 0 | 3 | 1 | |
| Levy[98] | 1913 | X | 3 | 3 | | | | | | | | | | | | | |
| Sardemann[152] | 1914 | X, S | 4 | 4 | | | | | | | | | | | | | |
| Nordentoft[132] | 1914 | X | 2 | 1 | | 1 | | | | | | | | | | | |
| Schmidt[154] | 1915 | X, P | 1 | 1 | | | | | | | | | | | | | |
| Heyerdahl[76-78] | 1916 | | | | | | | | | | | | | | | | |
| | 1919 | | | | | | | | | | | | | | | | |
| | 1927 | R | 21 | 21 | | | | | | | | | | | | | |
| Melchior[118] | 1916 | X, P | 3 | 3 | | | | | | | | | | | | | |
| Dittrich[36] | 1920 | X, S, P | 21 | 19 | 2 | 0 | | | | | | | | | | | |
| Steinkamm[163] | 1921 | X | 3 | 3 | | | | | | | | | | | | | |
| Jungling[87] | 1920 | X, S, P | 12 | 11 | | 1 | | | | | | | | | | | |
| Prikul[141] | 1921 | X, S | 1 | 1 | | | | | | | | | | | | | |
| Brofelt[21] | 1922 | X, S | 87 | 67 | | | 20 | 15 | | | 15 | | 49 | 22 | | 27 | |
| Brogden[22] | 1922 | X, S, P, Co | | | | | | | | | | | 14 | 2 | 3 | 6 | 3 |
| Beck[6] | 1922 | X, Ne, FP | | | | | | | | | | | 2 | 2 | | | |
| Sattler[153] | 1923 | X, S, P | | | | | | | | | | | 3 | 2 | | 1 | |
| Wakeley[171] | 1923 | X, S, P | 4 | 3 | | 1 | | 3 | | | 3 | | 2 | 2 | | | |
| New and Figi[130] | 1923 | R, S, P | 85 | 60 | 18 | 7 | | | | | | | | | | | |
| Kaplan[88] | 1924 | R, S | | | | | | | | | | | 1 | 1 | | | |
| Brunzel[23] | 1925 | X | 1 | 1 | | | | | | | | | | | | | |
| Eiken[43] | 1926 | X, S, P | 3 | 2 | 1 | | | | | | | | 1 | 1 | | | |
| Grünthal[62] | 1927 | X | | | | | | | | | | | 1 | 1 | | | |
| Tempsky[167] | 1927 | X, P | 36 | 32 | | | 4 | 4 | 1 | | 3 | | 3 | | 1 | 2 | |
| Desjardin[35] | 1928 | X, S, P | | | | | | 7 | | | 6 | 1 | | | | | |
| Heeren[68] | 1929 | X | 12 | 8 | 2 | 2 | | 3 | | | 2 | 1 | 23 | 1 | 5 | 17 | |
| Good[59] | 1930 | X, S, P | | | | | | 13 | | 1 | 6 | 6 | 1 | | | 1 | |
| Good[60] | 1931 | X, P | | | | | | | | | | | 55 | 8 | 6 | 29 | 12 |
| Stocker[164] | 1931 | X, P | 15 | 9 | | 3 | 3 | 5 | | 1 | 2 | 2 | 2 | 1 | | | 1 |
| Engelstad[48, 49] | 1932 | R | 28 | 25 | 1 | 1 | 1 | | | | | | | | | | |
| | 1933 | R | | | | | | | | | | | 1 | 1 | | | |
| Harrison[65] | 1934 | X | 22 | 22 | | | | 4 | | | 4 | | 4 | | | 4 | |
| Smith[160] | 1934 | X, S | 7 | 5 | 2 | | | | | | | | | | | | |
| Masson[115] | 1936 | X, P | | | | | | | | | | | 2 | 2 | | | |
| Martin[114] | 1936 | X | 3 | 3 | | | | | | | | | | | | | |
| Keijser[92] | 1936 | X, P | 69 | 64 | 3 | 2 | | 3 | | | 3 | | 27 | 9 | | 18 | |
| Weysser[180] | 1937 | X | | | | | | | | | | | 1 | | | 1 | |
| Kuhlmann[96] | 1937 | X, P | | | | | | 4 | | | 4 | | 1 | | | 1 | |
| Renander[145] | 1937 | X | 31 | 26 | | 5 | | 3 | | | 3 | | 13 | 5 | | 8 | |
| McWhirter[110] | 1938 | X | 8 | 7 | 1 | | | 2 | 1 | 1 | | | 4 | 3 | 1 | | |
| Starlinger[162] | 1938 | X, L, P | | | | | | | | | | | 1 | 1 | | | |
| Haldre and Koskvee[79] | 1941 | X, P | 120 | 87 | | 10 | 23 | 4 | 1 | 1 | 2 | | 17 | 9 | 2 | 6 | |
| Henkel[70] | 1941 | X, P | | | | | | | | | | | 2 | 2 | | | |
| Totals | | | 604 | 490 | 30 | 33 | 51 | 72 | 3 | 5 | 53 | 10 | 234 | 75 | 21 | 122 | 16 |

X, X-ray.
R, Radium.
P, Potassium iodide.
S, Surgery.
Co, Copper $SO_4$.
Ne, Neoarsphenamine.
FP, Foreign protein.
L, Lymph extract.
O, Number of cases.
I, Number of patients improved.
C, Number of patients cured.
D, Number of deaths.
N, No follow-up.

skin doses, a quantity infinitely greater than the amount employed in clinical therapy. He concluded that the effects of irradiation therapy in actinomycosis were nonspecific. Smith[160] theorized that either the actinomycete in vivo was more susceptible to irradiation than in vitro or the effectiveness of irradiation therapy resulted from the destruction of synergistic organisms in the actinomycotic lesions which enabled the natural defenses of the body to cope

with the actinomyces present. At the present time, clinical results prove the effectiveness of irradiation therapy in actinomycosis but the mode of action is unknown.

Extreme variations in therapeutic irradiation technique have been described with similar results attending most of them. The majority of radiologists used deep filtered x-rays in doses varying between 3,000 and 4,000 roentgens divided in different manners. Harrison[65] felt that the best results were obtained by using protracted fractional daily doses of 100 roentgens until 4,000 had been administered. At the other extreme Heeren[68] gave 90 to 120 per cent erythema skin doses at monthly intervals. Usually, potassium iodide and auxilliary surgical measures were employed. The superfluity of potassium iodide is known by some but definitely not accepted by all of the roentgen therapists. Some authors insisted upon adequate drainage and curettage of the lesions, but the majority shared Smith's[160] attitude toward surgery. He wrote, "Radical surgery, including curretting, is probably inadvisable. A study of the cases reported by the authors quoted herein shows that, all other things being equal, those cases which had a minimum of surgical interference recovered more rapidly than did the remainder. Surgical procedures should probably not be resorted to except to provide drainage and to assist in definitely establishing a diagnosis. They should then be limited to a small incision preferably a stab wound."

The efficacy of irradiation therapy in circumscribed superficial actinomycosis is established without a doubt. On the other hand, the results indicate its ineffectiveness in widespread disease.

*Vaccines.*—Specific vaccine therapy of actinomycosis was introduced by Wynn[186] in 1908. The method gained a few adherents in Europe, but has never enjoyed popularity in this country. Colebrook[29] of England and the Hungarian dermatologist, Neuber,[129] are the most energetic proponents of vaccine therapy. The former emphasized the value of concomitant surgery while the latter relied solely upon immunologic methods. A summary of the results with vaccine therapy by several authors is tabulated (see Table V).

The influence of surgical drainage and curettage upon the results reported and attributed to the vaccines is evident and emphasized by Colebrook,[29] who

TABLE V. RESULTS WITH VACCINE THERAPY OF ACTINOMYCOSIS

| | | | TYPES OF CASES AND RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
| AUTHOR | DATE | THERAPY | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Wynn[186] | 1908 | V, S | | | | | | 1 | 1 | | | | | | | | |
| Colebrook[29] | 1911 | V, S | 10 | 9 | | 1 | | 8 | | | 7 | 1 | 6 | 1 | | 5 | |
| Dean[34] | 1917 | V, S | 1 | 1 | | | | | | | | | | | | | |
| Schuchardt[156] | 1939 | V, S | 14 | 12 | | 2 | | | | | | | | | | | |
| Neuber[129] | 1940 | V | 2 | 2 | | | | 1 | 1 | | | | | | | | |
| Totals | | | 27 | 24 | | 3 | | 10 | 2 | | 7 | 1 | 6 | 1 | | 5 | |

V, Vaccine.
S, Surgery.
O, Number of cases.
C, Number of patients cured.
I, Number of patients improved.
D, Number of deaths.
N, No follow-ups.

wrote, "The treatment of actinomycosis by vaccines facilitates recovery when efficient surgical drainage of the affected tissue is secured and maintained; when, however, drainage is unsatisfactory the use of appropriate vaccines will not usually suffice to stay the progress of the infection." Colebrook's contribution to the treatment of actinomycosis was really surgical since throughout his report he insisted that in the absence of complete surgical drainage and curettage of the actinomycotic lesions the disease could not be cured. On the other hand, Neuber,[129] who claimed almost 100 per cent success with the vaccine treatment of actinomycosis, wrote that surgical measures, x-ray irradiation, and iodides are superfluous and unnecessary in curing the disease. He insisted that if the immunologic status of the patient suffering with actinomycosis is carefully evaluated regarding the presence of allergy or anergy and if fresh polyvalent or autovaccines are properly administered in only the allergic patients, cure of the disease is inevitable. The only failures he admits are in anergic patients and in these success may follow the administration of convalescent serum or blood transfusions. Although no statistical data are presented in his recent general review of the subject, the cases illustrated are quite impressive.

*Thymol.*—Thymol was found to be effective in the treatment of a local occupational fungus dermatitis among fruit orchard workers by Myers and Theines[126] in 1925. They cured a patient with cervicofacial actinomycosis by giving him 1.5 Gm. of thymol twice weekly for two months. Myers[125] observed that actinomyces were killed in vitro by exposure to 1:1000 concentration of thymol for one minute. Employing adequate surgical drainage with the oral administration and local application of thymol in six cases of cervicofacial actinomycosis, Myers[124] reported cures in five. A summary of the literature on the results of thymol therapy in the treatment of actinomycosis is appended in Table VI. Etter and Schumacher's[52] cured thoracic case is quite amazing. The patient had evidence of right upper lobe lung abscesses and coughed up considerable sputum containing sulfur granules. The process healed and x-ray evidence of the disease disappeared after the administration of 2 Gm. of thymol daily for seventeen days.

TABLE VI. RESULTS WITH THYMOL THERAPY OF ACTINOMYCOSIS

| AUTHOR | DATE | THERAPY | TYPES OF CASES AND RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
| | | | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Myers and Thienes[126] | 1925 | T | 1 | 1 | | | | | | | | | | | | | |
| Myers[124] | 1937 | T, S | 6 | 5 | | | 1 | | | | | | | | | | |
| Bancroft and Stanley-Brown[4] | 1938 | T, S | | | | | | | | | | | 1 | | 1 | | |
| Fang[53] | 1938 | T, Co | 1 | 1 | | | | | | | | | | | | | |
| Joyce[86] | 1938 | T | 5 | 3 | | | 2 | | | | | | | | | | |
| Etter and Schumacher[52] | 1939 | T | | | | | | | | | | | | | | | |
| Clemens[27] | 1940 | T | 1 | 1 | | | | 1 | 1 | | | | | | | | |
| Totals | | | 14 | 11 | | | 3 | 1 | 1 | | | | 1 | | 1 | | |

T, Thymol.
S, Surgery.
O, Number of cases.
C, Number of patients cured.
I, Number of patients improved.
D, Number of deaths.
N, No follow-up.
Co, Copper $SO_4$.

*Sulfonamides.*—Poulton[140] in 1937 applied sulfonamide therapy to a patient suffering with abdominal actinomycosis who responded badly to irradiation and potassium iodide. The report was part of a general discussion on sulfonamide therapy by the Royal Society of Medicine. He stated that his patient gained weight and left the hospital afebrile, but he did not mention whether or not she was cured. The apparent cure of an abdominal case of actinomycosis by means of sulfanilamide in a 23-year-old man who developed the disease following the removal of a gangrenous appendix was reported in 1938 by Walker.[175] This paper stimulated interest in the sulfonamides in the treatment of actinomycosis. The results obtained with sulfanilamide, sulfapyridine, and sulfadiazine in the treatment of cervicofacial, thoracic, and abdominal actinomycosis have been gratifying as is revealed in the summary of all of the cases reported in the available literature (see Table VII).

Although the sulfonamides were employed empirically in the treatment of actinomycosis by the pioneers of 1938, the rationale of the treatment has been

TABLE VII. RESULTS WITH SULFONAMIDE THERAPY OF ACTINOMYCOSIS

| AUTHOR | DATE | THERAPY | TYPES OF CASES AND RESULTS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
| | | | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Poulton[140] | 1937 | Sn | | | | | | | | | | | 1 | | 1 | | |
| Walker[175] | 1938 | Sn | | | | | | | | | | | 1 | 1 | | | |
| Miller and Fell[120] | 1939 | Sn | | | | | | | | | | | 1 | 1 | | | |
| Sudler and Johnson[165] | 1939 | Sn | 2 | 2 | | | | | | | | | | | | | |
| Hall[63] | 1939 | | | | | | | | | | | | | | | | |
| MacCharles and Kippen[105] | 1939 | Sn, S | 3 | 3 | | | | | | | | | | | | | |
| Moene[122] | 1940 | Sp, S | 1 | 1 | | | | | | | | | | | | | |
| Ogilvie[135] | 1940 | Sp, S | | | | | | | | | | | 1 | 1 | | | |
| Morton[123] | 1940 | Sn | 1 | | | | 1 | 1 | | | | 1 | | | | | |
| Christopher and Karabin[26] | 1940 | Sn, S | | | | | | | | | | | 1 | | 1 | | |
| Dorling and Eckhoff[39] | 1940 | Sn, S, X | | | | | | | | | | | 5 | 4 | | 1 | |
| Eckhoff[42] | 1941 | Sn, S | | | | | | | | | | | 2 | 2 | | | |
| Woodman[184] | 1941 | St, S, P | | | | | | | | | | | 1 | | | 1 | |
| Dobson et al.[38] | 1941 | Sn, S | 1 | 1 | | | | 1 | 1 | | | | 1 | 1 | | | |
| Wilkinson[181] | 1941 | Sn, S | | | | | | 1 | 1 | | | | | | | | |
| Mitchell[121] | 1942 | Sp | | | | | | 1 | 1 | | | | | | | | |
| Lyons et al.[104] | 1943 | | | | | | | | | | | | | | | | |
| Atwood[2] | 1942 | Sn | | | | | | 1 | 1 | | | | | | | | |
| Ladd and Bill[97] | 1943 | Sd | | | | | | 1 | 1 | | | | | | | | |
| Hollenbeck and Turnoff[80] | 1943 | Sd | 1 | 1 | | | | | | | | | | | | | |
| McCloy[107] | 1943 | Sp | 1 | 1 (tongue) | | | | | | | | | | | | | |
| Pillsbury and Wassersug[137] | 1944 | Sd, P | | | | | | 1 | 1 | | | | | | | | |
| Benbow et al.[9] | 1944 | | | | | | | 2 | 1 | 1 | | | | | | | |
| Dobson and Cutting[37] | 1945 | Sd, St, Sn | 7 | 6 | 1 | | | 1 | | | 1 | | 2 | | 1 | 1 | |
| Totals | | | 17 | 15 | 1 | | 1 | 10 | 7 | 1 | 1 | 1 | 16 | 10 | 3 | 3 | |

Sn, Sulfanilamide.
St, Sulfathiazole.
Sd, Sulfadiazine.
Sp, sulfapyridine.

S, Surgery.
X, X-ray.
P, Potassium iodide.
O, Number of cases.

C, Number of patients cured.
I, Number of patients improved.
D, Number of deaths.
N, No follow-up.

established experimentally by Cutting and Gebhardt[32] who found the growth of two strains of *Actinomyces hominis* was inhibited to some extent by the addition to the media of 10 mg. per cent of sulfanilamide and almost completely inhibited by the addition of 50 mg. per cent. Sulfathiazole and sulfadiazine were much more effective than sulfanilamide in similar concentrations. Experimental actinomycosis could be prevented or cured in rats by the oral administration of sulfanilamide.[40]

Ogilvie,[135] and Dodson, Holman, and Cutting[38] opined that the sulfonamides are beneficial in actinomycosis because of their effect on the concomitant secondary invaders which are inhibited by the drug, thus affording the natural defenses of the body an opportunity to dispose of the actinomyces. In all probability, the effectiveness of the drugs is due to inhibition of both the primary and secondary infectious agents.

Although there have been no definite opinions expressed regarding the simultaneous use of surgical drainage and curettage with the sulfonamides, it is interesting to note that in the majority of patients reported cured, a combination of surgical and drug therapy has been used. Although the number of cases reported is small and the poor results obtained with the drugs have probably not reached the literature, no doubt can exist that the sulfonamides are effective weapons in the treatment of actinomycosis.

*Penicillin.*—With the introduction of penicillin into therapeutics, it was not long before its effectiveness in the treatment of actinomycosis was assayed. In 1941 Florey[1] reported that a strain of *Actinomyces bovis* was as sensitive to the action of penicillin in vitro as the staphylococcus. The next year, Waksman and Woodruff[174] reported that two strains of *A. bovis* were not inhibited by therapeutic concentrations of penicillin in vitro. Fisher[54] found two strains of Actinomyces which were twice as resistant to the action of a crude penicillin extract as the staphylococcus. In 1945, he reported on another strain of Actinomyces which was very sensitive to the action of penicillin.[55]

Kenney and associates[91] found that a strain of Actinomyces was killed in vitro by 0.01 Oxford units of penicillin per cubic centimeter. They concluded that the Actinomyces more closely resembled the true bacteria than the fungi in respect to penicillin sensitivity as the other pathogenic fungi were not inhibited by penicillin in concentrations up to 10.0 Oxford units per cubic centimeter. Selbie and co-workers[157] found that ten strains of Actinomyces from human infections were all inhibited by therapeutic levels of penicillin. These organisms fell into two groups, however, one of which was two to four times more resistant to penicillin than the other. Three strains of Actinomyces from bovine source were much more resistant to penicillin than the human strains.

Dobson and Cutting[37] reported in vitro studies of three strains of Actinomyces using sulfadiazine and penicillin. Both drugs effectively inhibited growth. There was no synergistic effect when the drugs were used together. They concluded that sulfadiazine seemed to be more effective than penicillin at levels within the therapeutic range. They noted considerable variation in the sensitivity of the different strains of Actinomyces to penicillin.

The correlation between strain sensitivity and therapeutic results is best demonstrated by the work of Garrod[58] and Roberts and associates.[146] Christie and Garrod[25] reported on four patients with actinomycosis treated with penicillin in which the sensitivity of the infecting organisms to penicillin had been determined. Two of the individuals were infected with Actinomyces equally as sensitive to penicillin as the staphylococci. In these cases cures were obtained. The Actinomyces from the other patients were four and eight times more resistant to penicillin than the staphylococci, and penicillin therapy in these cases was unsuccessful. Roberts and co-workers have treated a patient with thoracic actinomycosis successfully with penicillin. Organisms obtained from this patient were as sensitive to penicillin as the staphylococci. The Actinomyces from another thoracic case in which penicillin therapy was not effective was found to be four times more resistant to the effect of penicillin than the staphylococci. It may be concluded from these observations that successful treatment of actinomycosis with penicillin depends to a large measure upon the individual strain sensitivity. If the infection fails to respond to prolonged treatment with penicillin, the question of the penicillin resistance of the organisms should be considered.

TABLE VIII. RESULTS WITH PENICILLIN IN THE TREATMENT OF ACTINOMYCOSIS

| AUTHOR | DATE | CERVICOFACIAL | | | | | THORACIC | | | | | ABDOMINAL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | C | I | D | N | O | C | I | D | N | O | C | I | D | N |
| Hudson[81] | 1943 | 1 | | | 1 | | | | | | | | | | | |
| Wollgast[183] | 1944 | 3 | 2 | | 1 | | | | | | | | | | | |
| Herrell[73] | 1944 | 3 | 2 | | 1 | | | | | | | 1 | | | 1 | |
| Garrod[58] | 1944 | 3 | 2 | | 1 | | 1 | | | 1 | | | | | | |
| Jones and Brownell[85] | 1945 | | | | | | 2 | 2 | | | | | | | | |
| Roberts et al.[146] | 1945 | | | | | | 2 | 1 | | 1 | | | | | | |
| Walker and Hamilton[176] | 1945 | 5 | 4 | | | 1 | 1 | 1 | | | | | | | | |
| McCrea et al.[108] | 1945 | 1 | 1 | | | | | | | | | | | | | |
| Hendrickson and Lehman[69] | 1945 | 2 | 2 | | | | | | | | | | | | | |
| Dobson and Cutting[37] | 1945 | 4 | 1 | 3 | | | 1 | 1 | | | | 1 | | 1 | | |
| Kay and Meade[89] | 1945 | | | | | | 2 | (Unimproved) 2 | | | | | | | | |
| Totals | | 22 | 14 | 3 | 4 | 1 | 9 | 5 | | 2 | | 2 | | 1 | 1 | |

O, Number.
C, Cured.
I, Improved.
D, Dead.
N, No follow-up.

In the accompanying Table VIII are reviewed the cases of actinomycosis treated with penicillin reported in the current literature. Only a few of the patients were treated exclusively with penicillin. Surgical incisions and drainage, sulfadiazine, and other agents were also employed. Penicillin was considered to be the main factor in the results obtained by all authors reporting cases. Its effectiveness is demonstrated by the large proportion of successfully treated patients and especially by its success with several cases of thoracic actinomycosis. Kolmer[95] advised that the use of penicillin in the treatment of actinomycosis be combined with surgical excision and drainage and with the use of sulfadiazine, although the cases of Hendrickson and Lehman[69] indicated that this is not always necessary. Both Kolmer[95] and Herrell[74] advised repeated courses of penicillin treatment in view of the chronicity of the disease.

## DISCUSSION

An attempt has been made to evaluate the efficiency of the various techniques employed in the treatment of cervicofacial, thoracic, and abdominal actinomycosis as they have been reported in the literature. The therapeutic results with surgery, radiation, vaccines, thymol, the sulfonamides, and penicillin are summarized in Table IX. The information to be obtained from this review

TABLE IX. SUMMARY OF THERAPEUTIC RESULTS IN ACTINOMYCOSIS

| TYPE OF TREATMENT* | AUTHORS | CASES | CURED | | DEAD | | IMPROVED | | NO FOLLOW-UP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | NO. | % | NO. | % | NO. | % | NO. | % |
| *Cervicofacial Actinomycosis* | | | | | | | | | | |
| Surgery | 9 | 96 | 69 | 72 | 9 | 9 | 10 | 11 | 8 | 8 |
| Irradiation | 28 | 604 | 490 | 81 | 33 | 5 | 30 | 5 | 51 | 9 |
| Vaccine | 4 | 27 | 24 | 89 | 3 | 11 | | | | |
| Thymol | 7 | 14 | 11 | 78 | | | | | 3 | 22 |
| Sulfonamides | 24 | 17 | 15 | 88 | | | 1 | 6 | 1 | 6 |
| Penicillin | 8 | 22 | 14 | 63 | 4 | 18 | 3 | 13 | 1 | 6 |
| *Thoracic Actinomycosis* | | | | | | | | | | |
| Surgery | 11 | 26 | 3 | 11 | 19 | 71 | 2 | 9 | 2 | 9 |
| Irradiation | 14 | 72 | 3 | 4 | 54 | 75 | 5 | 7 | 10 | 14 |
| Vaccine | 3 | 10 | 2 | 20 | 7 | 70 | | | 1 | 10 |
| Thymol | 1 | 1 | 1 | | | | | | | |
| Sulfonamides | 9 | 10 | 7 | 70 | 1 | 10 | 1 | 10 | 1 | 10 |
| Penicillin | 5 | 7 | 4 | 57 | 2 | 28 | 1 | 14 | | |
| *Abdominal Actinomycosis* | | | | | | | | | | |
| Surgery | 16 | 70 | 15 | 21 | 45 | 66 | 9 | 12 | 1 | 1 |
| Irradiation | 26 | 235 | 75 | 32 | 123 | 52 | 21 | 9 | 16 | 7 |
| Vaccine | 1 | 6 | 1 | 16 | 5 | 84 | | | | |
| Thymol | 1 | 1 | | | | | 1 | | | |
| Sulfonamides | | 16 | 10 | 56 | 3 | 18 | 3 | 18 | 3 | 18 |
| Penicillin | 2 | 2 | | | 1 | 50 | 1 | 50 | | |

*The types of treatment are listed as emphasized by authors using them. However, potassium iodide was used in connection with surgery and radiation in many cases. Surgical drainage was used to some extent with radiation therapy and extensively in the patients treated with vaccines, thymol, sulfonamide, and penicillin.

affords only a relative evaluation of the efficacy of the methods of treatment employed since no controlled studies were made and the therapeutic difficulties in many cases of actinomycosis have led to the use of different combinations of treatments. Generally no classification relative to the severity of the original disease at the time of institution of therapy was made. In spite of these statistical defects in this review, a few trends in the results of treatment of the different types of actinomycosis with the various techniques are obvious.

The extent, penetration, and accessibility of the actinomycotic infection determine its response to treatment. The more superficial and circumscribed cervicofacial disease seemed to be amenable to all of the methods offered. The deep, extensive, and occult abdominal and thoracic actinomycotic infections offered a grave prognosis until the advent of the use of sulfonamides and penicillin in their treatment. Particularly in thoracic actinomycosis, which was formerly almost uniformly a fatal disease, has the mortality been markedly reduced. Their favorable influence on the progress of abdominal actinomycosis has likewise been proved. In the latter disease we believe, however, that they must be used as adjuvants to radical surgical removal of actinomycotic tissue.

TABLE X. SUMMARY OF CASES

| HOSPITAL NO. AND AGE (YR.) | DATE | TYPE | SYMPTOMS | THERAPY | RESULT |
|---|---|---|---|---|---|
| | | | *Cases of Cervicofacial Actinomycosis* | | |
| 35924*† Male, 43 | 1925 | 3 | Swelling over left zygoma with extension to involve left side of face from infra-orbital region to neck | KI, hot packs; incision of abscesses on 5 occasions | Died; had extension into posterior mediastinum with involvement of esophagus at post-mortem |
| 38703*† Male, 65 | 1926 | 2 | Hard swelling on right side of face extending down on the neck and under the chin; numerous sinuses | X-ray irradiation; incision and curettage, KI | Cured |
| 42626*† Male, 34 | 1927 | 1 | Large indurated swelling of left side of face extending from ear over the maxilla and down into the neck | KI, Lugol's solution, x-ray irradiation; incision of abscess | Cured |
| 44891*† Male, 40 | 1930 | 1 | Hard reddened swelling on right cheek | Excision with endotherm cutting current | Cured |
| 60926*† Female, 29 | 1931 | 1 | Swelling in left submaxillary region | Excision | Cured |
| 608171*† Female, 13 | 1932 | 1 | Red indurated mass in right side of face | Partial excision and curettage | Cured |
| 621288† Female, 31 | 1933 | 3 | 8-year history, comatose on admission, numerous sinuses on left side of face, exophthalmus of left eye | Supportive | Died; post-mortem showed extension into epidural space, orbit, and liver |
| 622467† Male, 65 | 1933 | 2 | Swelling of right jaw; draining sinus over right maxilla | KI, x-ray irradiation, numerous incisions and curettements | Died; post-mortem showed actinomycotic meningitis |
| 631495† Male, 7 | 1934 | 1 | Large swelling on right side of face | Curettage on 2 occasions | Cured |
| 656703 Male, 24 | 1937 | 1 | Mass in left side of neck | Repeated excision and curettement | Cured |
| 659875 Female, 5 | 1937 | 1 | Painful swelling at angle of jaw | Curettement | Cured |
| 664208 Male, 55 | 1937 | 2 | Tender swelling and induration in right neck and jaw; draining sinus | Repeated curettement | Improved, no follow-up |
| 708879 Female, 26 | 1941 | 3 | 4 months' history, multiple draining sinuses on right side of face, massive infection, cachexia | Repeated curettage; supportive | Died, post-mortem showed actinomycotic meningitis, extension to bones and lung |
| 725491 Male, 18 | 1942 | 1 | Swelling and pain over right mandible | X-ray irradiation, Lugol's, curettage; sulfonamides | Cured |
| 752975 Male, 53 | 1944 | 1 | Submental swelling | Excision and curettage | Cured |

| | | | | | |
|---|---|---|---|---|---|
| 62058† Male, 46 | 1932 | 2 | Swelling below angle of jaw with draining sinus | Radical neck dissection, curettage | Cured |
| | | | *Cases of Lingual Actinomycosis* | | |
| 611438*† Male, 39 | 1932 | S | Sore, swollen tongue | Incision and curettement | Cured |
| 594071 Male, 43 | 1930 | | Glossitis | Incision and drainage, abscess on 2 occasions | Cured |
| | | | *Cases of Thoracic Actinomycosis* | | |
| 50972*† Male, 21 | 1927 | | Draining sinus in left chest, weight loss, night sweats, diarrhea, periosteitis of ribs | X-ray irradiation, KI, incision and drainage of abscesses | Died, post-mortem showed actinomycosis of lung, bronchopneumonia |
| 55740*† Male, 13 | 1930 | | Density in right lower lobe pericarditis, pleural effusion, ascites | Supportive | Died, post-mortem showed actinomycosis of lungs, mediastinum, diaphragm and pericardium |
| 615300*† Female, 29 | 1930 | | Marked limitation of motion of left chest, hard swelling beneath left breast, mass in left axilla, periosteitis of ribs | X-ray irradiation; excision, drainage and curettement repeatedly; KI | Died after 5-year course; no post-mortem |
| 640072† Female, 14 | 1935 | | Encapsulated empyema on left side, unresolved pneumonia in left upper lobe, periosteitis of ribs | Repeated rib resections, incisions and drainage | Died, post-mortem showed active mycosis of entire left chest, pulmonary edema of right lung |
| 646743† Male, 45 | 1935 | | Appendectomy followed by postoperative pneumonia and empyema; encapsulated empyema on right side | Repeated excision, incision, curettage and rib resection | Died, post-mortem showed actinomycosis of chest wall, multiple lung abscesses, liver abscesses, brain abscess |
| 736707 Male, 44 | 1944 | | Draining sinus on right anterior chest wall for 8 years; subdiaphragmatic abscess | Sulfamerazine; patient became sensitive to drug; sulfadiazine; 3-week course | Improved; no follow-up |
| 746923 Male, 57 | 1944 | | Left lower lobe pneumonia followed by empyema; draining sinus below eleventh rib posteriorly | Repeated curettage, excision and rib resection | Died of cerebrovascular accident while under treatment; actinomycosis had improved |
| | | | *Cases of Abdominal Actinomycosis* | | |
| 12506† Male, 37 | 1917 | | Draining appendectomy wound, two large masses posteriorly in right flank | Cauterization, excision and unroofing of abscess | Died, no post-mortem |
| 50181*† Male, 37 | 1928 | 3 | Draining sinus in right lower quadrant; indurated mass involving thigh and right buttock, flexion of right hip, periosteitis of pubis, developed fecal fistula | KI, x-ray irradiation, incision of abscess | Died, no post-mortem |
| 44025 Female, 40 | 1928 | 2 | Pain and mass in right lower quadrant, chills, fever, cachexia | Supportive, drainage of subdiaphragmatic abscess | Died, post-mortem showed actinomycosis of ovary, lungs, liver, intrahepatic thrombosis |

*Reported by Randall.[143]
†Reported by Wangensteen.[177, 178]

*(Cont'd on following page.)*

TABLE X (CONT'D)

| HOSPITAL NO. AND AGE (YR.) | DATE | TYPE | SYMPTOMS | THERAPY | RESULT |
|---|---|---|---|---|---|
| 56820*† Female, 51 | 1928 | 3 | Draining appendectomy wound, thrombophlebitis of right leg, flexed right thigh | KI, x-ray irradiation, repeated curettement | Died, no post-mortem |
| 611198 Male, 22 | 1937 | 3 | Two draining sinuses in right lower quadrant, mass in right lower quadrant, flexed right thigh; developed subdiaphragmatic abscess with invasion of lung and pleura | Repeated drainage and curettements | Died; postmortem revealed actinomycosis of abdominal wall, liver, and intestine with subdiaphragmatic abscess and extension into pleura and chest |
| 612412*† Male, 15 | 1932 | 2 | Draining sinuses under left costal margin, periosteitis of ribs, left hydrothorax, cachexia, mass in left upper quadrant | Drainage of abdominal abscess | Died, post-mortem showed actinomycotic abscesses of spleen and liver, extensions through both diaphragms into pleural cavities and intra-abdominal fistula |
| 613527*† Male, 59 | 1931 | 1 | Chronic draining sinus in right lumbar region, subcutaneous nodules | Two curettements of sinus | Died, after course of 6 yr. 4 mo. in local hospital of "actinomycosis of lungs" |
| 640854† Male, 28 | 1935 | 3 | Draining right lower quadrant sinus with fecal fistula, enlarged liver, right lumbar abscess | Repeated incision and drainage, unroofing of abscess | Died, post-mortem revealed ascites, multiple sinuses, fecal fistula, actinomycosis of cecum, multiple liver abscesses |
| 646103† Male, 57 | 1936 | 3 | Multiple draining sinuses in the right lower quadrant and right upper quadrant, induration of entire right abdominal wall; terminal upon admission | Supportive | Died, post-mortem showed actinomycosis of abdominal wall with extension into chest |
| 662213 Male, 22 | 1937 | 3 | Several right lower quadrant sinuses, fecal fistula, cachexia | Repeated curettage of the sinuses | Died, post-mortem showed actinomycosis of abdomen and liver, fecal fistula |
| 709649 Male, 38 | 1941 | 1 | Acute appendicitis with appendical abscess; wound failed to heal; process continued to expand | Appendectomy, drainage of abscess, curettage; x-ray therapy, sulfadiazine, KI | Died, post-mortem showed pulmonary and abdominal actinomycosis |
| 736387 Male, 11 | 1944 | 3 | Appendectomy followed by abscess; developed large right upper quadrant mass, febrile, cachexic, colobiliary-bronchial fistula | Repeated laparotomy for drainage of abscess | Died, post-mortem showed extensive peritonitis, multiple liver abscesses |
| 740820 Male, 52 | 1944 | 3 | Draining sinuses in left lower quadrant, in right buttock and over sacrum; flexed right hip, fecal fistula | Repeated excision, transverse colostomy, energetic supportive treatment | Improved, no follow-up |
| 746676 Female, 17 (Case report given in detail) | 1944 | 3 | Multiple sinuses over right iliac crest, flexed right hip, cachexia | Repeated excision and unroofing of abscess, skin grafting; energetic supportive treatment | Cured |

The coapplication of sulfonamides and penicillin with radiation therapy in extensive actinomycosis has not to our knowledge been evaluated.

## REPORT OF CASES

The cases reported here have been encountered at this hospital over the last twenty-five years. During this period, all forms of therapy except the vaccines and thymol have been used. Most of the patients have been treated by more than one agent. In every case reported, microscopic granules characteristic of actinomycosis have been demonstrated. The cervicofacial cases have been classified into three types according to their extent: (1) a circumscribed abscess or area of induration with sinuses, (2) lesions with sinuses but not invading vital structures, (3) lesions extending into the orbit, sinuses, mediastinum, or spine. The thoracic cases could not be classified in this manner as no suitable division could be decided upon. The abdominal cases have been classified according to a slightly modified form of the scheme suggested by Morton: (1) those resembling acute appendicitis with a residual sinus tract, (2) those presenting a mass in the abdomen without signs of obstruction, (3) those associated with a flexed thigh or a fecal fistula or extension through the diaphragm. The purpose of the classification of the lesions was to determine the relationship between the extent of the lesion and the prognosis.

Fig. 2.—Condition of the patient on admission, showing the cachexia and the flexed thigh.

Case 39. (Severe Abdominal Actinomycosis, Morton type 3).—The patient was a 17-year-old girl who was first admitted to the University Hospitals on Aug. 8, 1944. Past history dated from January, 1944, when she had an attack of right lower quadrant pain, nausea, and vomiting lasting two days. Following this she gradually developed a flexion deformity of the right hip accompanied by severe backaches. She first consulted her local doctor in March, 1944. The diagnosis of ruptured appendix was made and she was hospitalized. On March 27, 1944, she underwent appendectomy which was followed by a stormy postoperative course, although the operative wound healed primarily. On the tenth postoperative day the patient left the hospital with a temperature of 102° F. Her general condition deteriorated progressively and multiple sinus tracts appeared along the right iliac crest. In July, 1944, she was again hospitalized by her local doctor and given 800,000 units of penicillin without effect. She grew progressively worse until she was admitted to the University Hospital in August, 1944.

On admission, the past history except as noted was noncontributory. Physical findings were: emaciation (weight, 33.2 kilograms), pallor, weakness, dental caries, healed right rectus incision, pitting edema of the legs and vulva, severe right psoas spasm, and numerous draining sinuses above the right iliac crest extending posteriorly to the vertebral column

(Fig. 2). The pus from the sinuses contained typical sulfur granules. Laboratory findings were hemoglobin, 6 Gm.; total plasma proteins, 6.9 Gm. per cent with a reversal of the albumin globulin ratio. X-ray examination showed the lumbar vertebrae to be free of disease. An intravenous pyelogram demonstrated normal kidneys and ureters. A barium enema showed displacement of the cecum by an extrinsic mass. A diagnosis of right lower quadrant abdominal actinomycosis (Morton type 3) accompanied by secondary anemia and cachexia was made.

Treatment was directed at the restoration of general health and surgical extirpation of the actinomycotic tissue. Supportive therapy was carried out with vigor (Fig. 3). The anemia was treated with ferrous sulfate and liberal transfusions, 3,500 c.c. of whole blood being administered in the first two weeks of treatment and a total of 10,750 c.c. throughout the hospital stay. The patient maintained an average intake of 3,500 calories daily. The efficacy of the supportive therapy was checked repeatedly by determinations of the hemoglobin, plasma proteins, and weight.

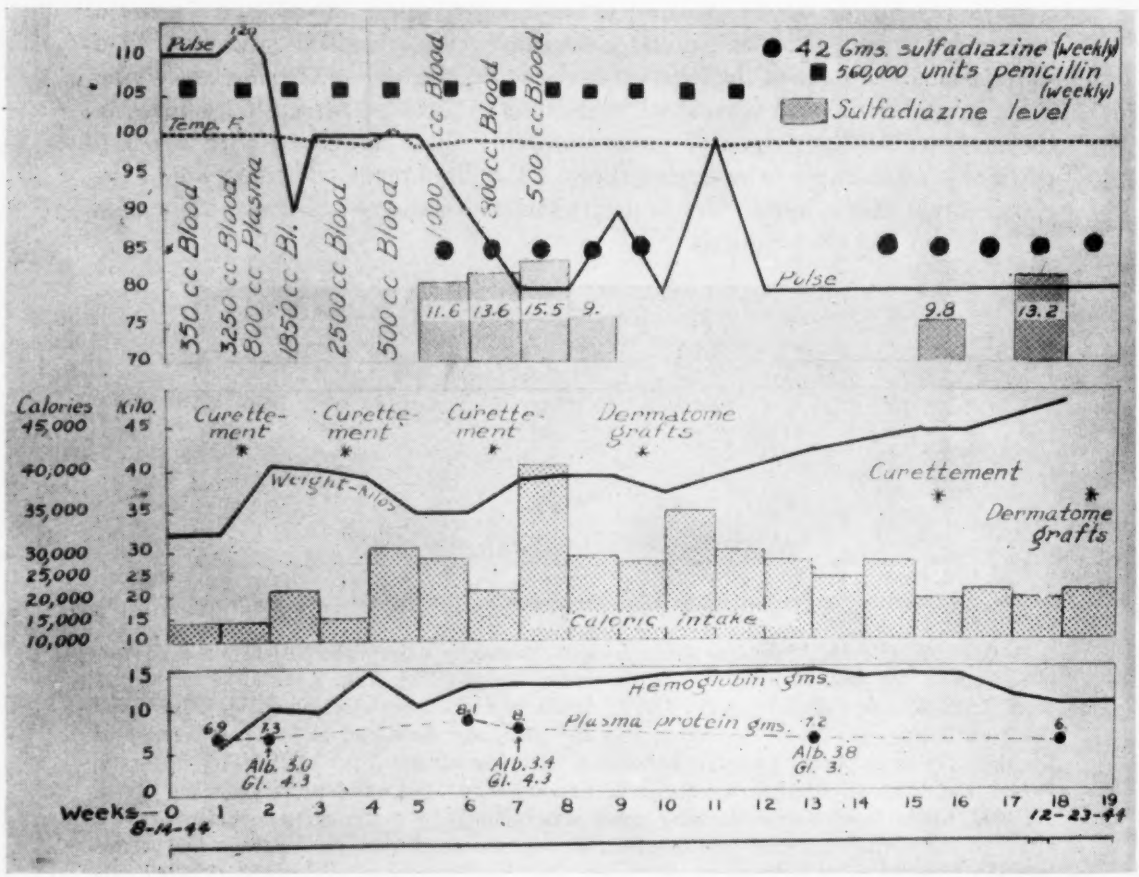


Fig. 3.—Graph cataloguing the treatment of the patient and its reflection upon the body economy.

The patient received 10,000 units of penicillin intramuscularly every three hours for twelve weeks. For five weeks during this period the patient was also given sulfadiazine, 1 Gm. every four hours, an average level of 12.4 Gm. per cent being maintained. For five weeks after leaving the hospital, the patient was given sulfadiazine at home in the same dosage (Fig. 3).

The surgical treatment consisted of the removal of the affected tissue in three stages by means of radical excision and curettage (Aug. 25, 1944, Sept. 7, 1944, Sept. 28, 1944)

(Fig. 4). Extreme caution was observed while curetting in the region of the cecum to avoid the production of a fecal fistula. The abdominal muscles were detached from the right iliac crest and tissue was removed over the psoas and iliacus muscles posteriorly to the vertebral column, superiorly to the lower pole of the right kidney, and inferiorly into Scarpa's triangle. The wound was irrigated daily with hydrogen peroxide followed by Dakin's solution, and was packed with gauze impregnated with dichloramine-T in oil. Granulations progressed favorably. The posterior aspect of the wound was grafted with split thickness grafts on Oct. 19, 1944. The remainder was covered in a similar manner on Jan. 2, 1945. The patient has continued

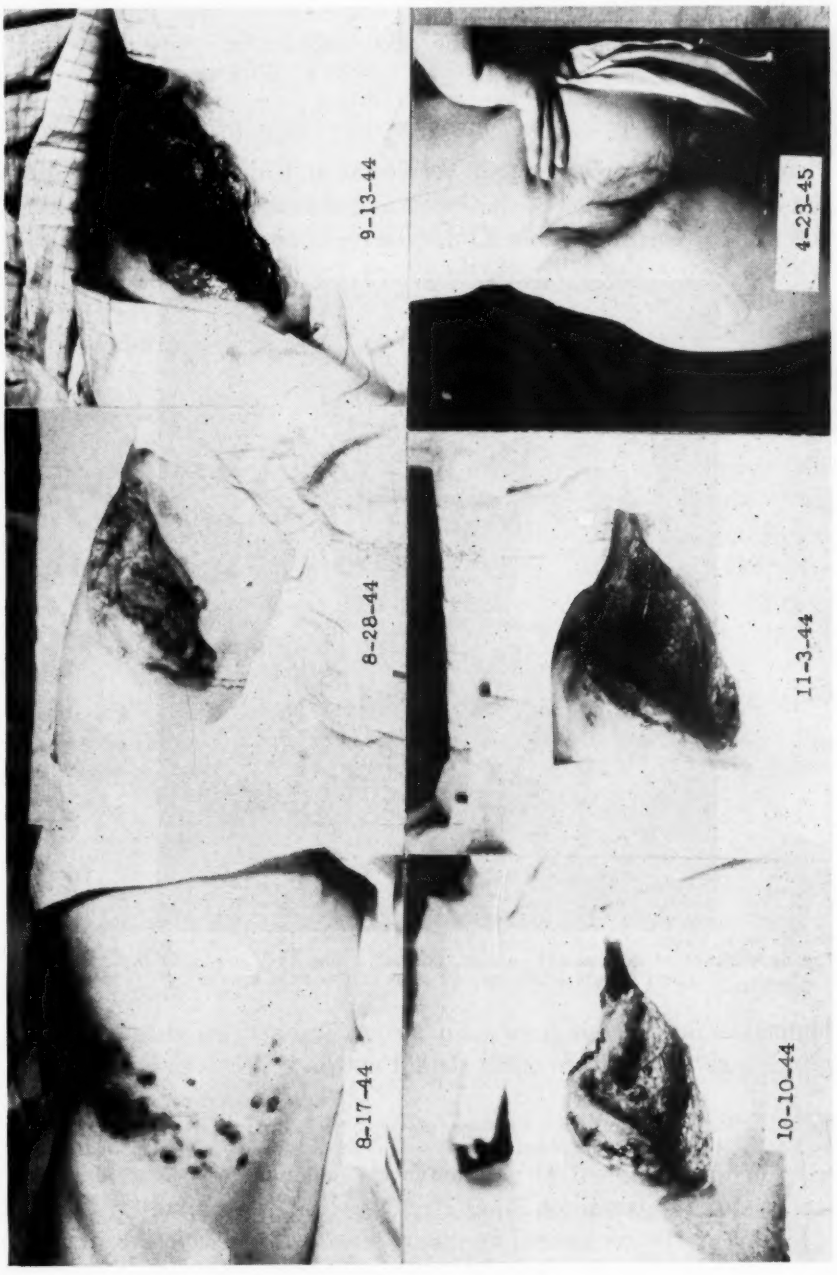


Fig. 4.—*A*, Initial appearance of the sinus tracts; *B*, after the first excision; *C*, after the second excision; *D*, after the third excision showing the iliacus and psoas muscles forming the floor of the wound; *E*, prior to skin grafting; *F*, after skin grafting.

to gain weight and strength (Fig. 5). There has been no evidence of recurrence of the disease. A mild scoliosis of the spine has resulted from the detachment of the abdominal muscles from the iliac crest.

We believe the apparent cure of this severe case of abdominal actinomycosis was the result of energetic supportive treatment, adjuvant chemotherapy, and radical surgical excision of infected tissue coupled with meticulous wound care. The application of dermatome grafts enabled a shortened convalescent period. The favorable course of events with this therapeutic regimen in such a severe case of actinomycosis suggests that the prognosis in extensive abdominal actinomycosis is not entirely hopeless.

## RESULTS

The results in the treatment of cervicofacial actinomycosis show a close correlation between the extent of the lesion at the time treatment was instituted and the eventual prognosis (Table XI). The results in the treatment of thoracic

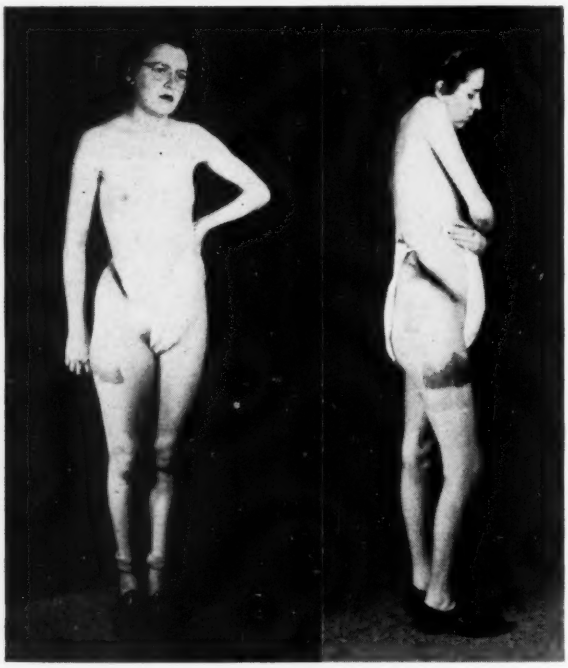

Fig. 5.—The appearance of the patient on Jan. 15, 1945. The dark areas on the right thigh and buttock are healed donor sites of the skin grafts.

and abdominal actinomycosis have been poor. The success with the last case, however, indicates that the prognosis should not be hopeless in any of these patients.

## CONCLUSIONS

Success in the treatment of actinomycosis depends to a large extent upon early diagnosis of the condition since circumscribed lesions will respond satisfactorily to any of the recognized forms of treatment. Extensive involvement

TABLE XI. RESULTS IN THE TREATMENT OF SIXTEEN CASES OF CERVICOFACIAL ACTINOMYCOSIS CLASSIFIED AS TO TYPE

| TYPE | NUMBER | CURED | HEALING | DEAD |
|---|---|---|---|---|
| 1 | 7 | 5 | 2 | 0 |
| 2 | 6 | 5 | – | 1 |
| 3 | 3 | – | – | 3 |

irrespective of location presents a serious threat to the life of the patient and a challenge to the ingenuity and perseverance of the physician.

Cervicofacial actinomycosis has proved relatively amenable to irradiation, surgery, or chemotherapy. The mortality of this type of infection results from extensions of the infection into vital structures. Repeated excision and curettage as emphasized by Wangensteen[178] appears to be the treatment of choice in extending infections. Adjuvant chemotherapy enhances the possibility of success in the extensive lesions treated by surgery.

Thoracic actinomycosis has been notoriously resistant to treatment prior to the advent of modern chemotherapeutic agents. The sulfonamides and penicillin should bear the burden of treatment in these cases. Surgery should be limited to the drainage of collections of pus and the excision of grossly infected tissue.

Results in the treatment of abdominal actinomycosis have been generally poor. Irradiation therapy of these lesions has been limited by the technical difficulties encountered in applying the treatment to the ramifications of the infected tissue. Aggressive surgical treatment of abdominal actinomycosis has been limited by the poor general condition of the patients. The role of supportive treatment (that is, high caloric intake, liberal transfusions) and adjuvant chemotherapy is to restore and maintain the general condition of the patient at a level tolerating repeated radical excision and curettage of the lesion. Favorable progress of the local lesion depends upon meticulous wound hygiene with the inhibition of secondary infection.

With the conscientious application of generous supportive treatment combined with radical surgery, the prognosis in extensive actinomycosis should continue to improve.

REFERENCES

1. Abraham, E. P., and others: Further Observations on Penicillin, Lancet **241**: 177-188, 1941.
2. Atwood, H. S.: Actinomycosis of the Lung: Minimal Infection, Northwest Med. **41**: 419-420, 1942.
3. Axhausen, G.: Das Fruhbild der Kieferaktinomykose, Deutsche Med. Wchnschr. **62**: 1449-1451, 1936.
4. Bancroft, F. W., and Stanley-Brown, M.: The Treatment of Actinomycosis With Thymol Ann. Surg. **108**: 468-471, 1938.
5. Bayne-Jones, S.: Club Formation by Actinomyces hominis in Glucose Broth With a Note on B. actinomycetum-comitans, J. Bact. **10**: 569-575, 1925.
6. Beck, Kiel: Vorstellung von zwei geheilten Bauchaktinomykosefallen, Zentralbl. f. Chir. **49**: 1775, 1922.
7. Bell, E. T.: A Textbook of Pathology, ed. 4, Philadelphia, 1941, Lea & Febiger.
8. Bell, J.: Actinomycosis: Introduction and Recital of Cases, Montreal M. J. **34**: 81-86, 1905.
9. Benbow, E. P., Jr., Smith, D. T., and Grimson, K. S.: Sulfonamide Therapy in the Treatment of Actinomycosis: 2 Cases of Aerobic Partially Acid-fast Actinomyces, Am. Rev. Tuberc. **49**: 395-407, 1944.

10. Bergey, David H., and others: Bergey's Manual of Determinative Bacteriology, ed. 5, Baltimore, 1939, Williams and Wilkins Company.
11. Bevan, A. D.: Actinomycosis, Ann. Surg. **41**: 641-654, 1905.
12. Bevan, A. D.: Treatment of Actinomycosis and Blastomycosis With Copper Salts, J. A. M. A. **45**: 1492-1493, 1905.
13. Bibby, B. G., and Knighton, H. T.: The Actinomyces of the Human Mouth, J. Infect. Dis. **69**: 148-154, 1941.
14. Biggart, J. H.: Actinomycosis Graminis, Bull. Johns Hopkins Hosp. **54**: 165-173, 1934.
15. Bisgard, J. D.: Actinomycosis Thoracic: Report of Two Arrested Cases, J. Thoracic Surg. **8**: 570-575, 1939.
16. Bollinger, O.: Ueber eine neue Pilzkrankheit beim Rinde, Centralb. f. d. med. Wissensch., Berl. **15**: 481, 1877.
17. Bostroem: Untersuchungen über die Aktinomykose des Menschen, Beitr. z. path. Anat. u. z. allg. Path. **9**: 1-240, 1891.
18. Boyd, W.: Surgical Pathology, ed. 5, Philadelphia, 1943, W. B. Saunders Company.
19. Brickner, W. M.: Pelvic Actinomycosis: A Study of Five Consecutive Cases Successfully Treated by Operation, Ann. Surg. **81**: 303-367, 1925.
20. Brockman, R. St. L.: Actinomycosis of the Right Iliac Fossa, Brit. J. Surg. **10**: 456-465, 1923.
21. Brofelt, S.: Sur l'actinomycose en Finlande, Acta Chir. Scandinav. **55**: 167, 1922.
22. Brogden, J. C.: Actinomycosis of the Gastrointestinal Tract; A Study of Fourteen Cases, J. Lab. & Clin. Med. **8**: 180-189, 1922.
23. Brunzel, H. F.: Kaguistischer Beitrag zur Behandlung der Aktinomykose mit Röntgenstrahlen, Strahlentherapie **6**: 253-256, 1915.
24. Choyce, C. C.: Actinomycosis of the Abdominal Wall, Proc. Roy. Soc. Med. **4**: 79-82, 1910.
25. Christie, R. V., and Garrod, L. P.: A Review of the Work of a Penicillin Therapeutic Research Unit, Brit. M. J. **1**: 513-514, 1944.
26. Christopher, F., and Karabin, J. E.: Abdominal Actinomycosis: Recovery Following Surgical Treatment and the Use of Zinc Peroxide and Sulfanilamide, Am. J. Surg. **50**: 371-372, 1940.
27. Clemens, H. H.: Actinomycosis; Report of a Case in a Child With Recovery Following Thymol Therapy, J. Pediat. **16**: 487-494, 1940.
28. Colebrook, L.: The Mycelial and Other Micro-Organisms Associated With Human Actinomycosis, Brit. J. Exper. Path. **1**: 197-212, 1920.
29. Colebrook, L.: A Report on Twenty-Five Cases of Actinomycosis With Special Reference to Vaccine Therapy, Lancet **200**: 893-899, 1921.
30. Cope, V. Z.: A Clinical Study of Actinomycosis With Illustrative Cases, Brit. J. Surg. **3**: 35-81, 1915.
31. Cope, V. Z.: Actinomycosis, London, 1938, Oxford University Press.
32. Cutting, W. C., and Gebhardt, L. P.: Inhibitory Effects of Sulfonamides on Cultures of Actinomyces hominis, Science **94**: 568-569, 1941.
33. Davis, D. J.: The Actinomyces-like Granules in Tonsils, J. Infect. Dis. **14**: 144-158, 1914.
34. Dean, C. W.: A Case of Actinomycosis Successfully Treated by Vaccine, Brit. M. J. **1**: 82-83, 1917.
35. Desjardin, A. A.: Radiotherapy in Actinomycosis, Radiology **11**: 321-332, 1928.
36. Dittrich, R.: Die Röntgenstrahlenbehandlung der Gesichts und Halsaktinomykose, Med. Klin. **16**: 394-396, 1920.
37. Dobson, L., and Cutting, W. C.: Penicillin and Sulfonamides in the Therapy of Actinomycosis, J. A. M. A. **128**: 856-863, 1945.
38. Dobson, L., Holman, E., and Cutting, W.: Sulfanilamide in the Therapy of Actinomycosis, J. A. M. A. **116**: 272-275, 1941.
39. Dorling, G. C., and Eckhoff, N. L.: Chemotherapy of Abdominal Actinomycosis, Lancet **2**: 707-709, 1940.
40. Dosa, A.: Travaux originaux—Die Heilwirkung des Sulfanids auf die experimentell erzengte und aktinomykose der ratte, Acta dermat.-venereol. **22**: 315-319, 1941.
41. Drake, C. H., Sudler, M. T., and Canutson, R. I.: A Case of Staphylococcic Actinophytosis (Botryomycosis) in Man, J. A. M. A. **123**: 339-340, 1943.
42. Eckhoff, N. L.: Actinomycosis, Guy's Hosp. Gaz. **55**: 64-67, 1941.
43. Eiken, T.: Ueber die Röntgenbehandlung der Aktinomykose, Acta Radiol. **6**: 391-398, 1926.
44. Ellis, R. W. B.: Actinomycosis in Childhood; A Clinical Study and Review, Arch. Dis. Childhood **10**: 1-24, 1935.
45. Emmons, C. W.: Actinomyces and Actinomycosis, Puerto Rico J. Pub. Health and Trop. Med. **11**: 63-76, 1935.

46. Emmons, C. W.: Strains of Actinomyces Bovis Isolated From Tonsils, Puerto Rico J. Pub. Health and Trop. Med. **11**: 720-727, 1936.
47. Emmons, C. W.: The Isolation of A. Bovis From Tonsillar Granules, Pub. Health Rep. **53**: 1967-1975, 1938.
48. Engelstad, R. B.: Radiumbehandlung av ansikts og halsaktinomykose, Norsk Mag. f. Laegevidensk. **93**: 161-175, 1932.
49. Engelstad, R. B.: Radiumbehandlung av abdominal aktinomykose, Norsk Mag. f. Laegevidensk. **94**: 759-763, 1933.
50. Erikson, D.: The Pathogenic Aerobic Organisms of the Actinomyces Group, Medical Research Council (British), Special Report Series No. 203, 1935.
51. Erikson, D.: Pathogenic Anaerobic Organisms of the Actinomyces Group, Medical Research Council (British), Special Report Series No. 240, 1940.
52. Etter, L. E., and Schumacher, F. L.: Pulmonary Actinomycosis: Recovery After Thymol Therapy, J. A. M. A. **113**: 1023-1024. 1939.
53. Fang, H. C.: Thymol in the Treatment of Actinomycosis, Chinese M. J. **54**: 448-453, 1938.
54. Fisher, A. M.: The Antibacterial Properties of Crude Penicillin, Bull. Johns Hopkins Hosp. **73**: 343-373, 1943.
55. Fisher, A. M.: The Therapeutic Value of Penicillin Applied Locally, Bull. Johns Hopkins Hosp. **76**: 134-153, 1945.
56. Florey, M. E., and Florey, H. W.: General and Local Administration of Penicillin, Lancet **1**: 387-396, 1943.
57. Gangolphe, M., and Duplant, F.: Typhlite and Appendicite Actinomycosique, Rev. de Chir., Par. **17**: 503-518, 1897.
58. Garrod, L. P.: The Laboratory Control of Penicillin Treatment, Brit. Med. J. **1**: 528-530, 1944.
59. Good, L. P.: Actinomycosis of the Thorax, Arch. Surg. **21**: 786-800, 1930.
60. Good, L. P.: Actinomycosis of the Abdomen, Arch. Surg. **22**: 307-313, 1931.
61. Griffith, F.: Actinobacillosis: On the Pathology of Bovine Actinomycosis, J. Hyg. **15**: 195-207, 1915.
62. Grünthal, J.: Zur Behandlung der Bauchaktinomykose mit Röntgenstrahlen, Fortschr. a. d. Geb. d. Roentgenstrahlen **36**: 1085-1090, 1927.
63. Hall, W. E. B.: Sulfanilamide in Actinomycosis, J. A. M. A. **112**: 2190, 1939.
64. Harbitz, F., and Grondahl, N. B.: Actinomycosis in Norway, Am. J. M. Sc. **142**: 386-395, 1911.
65. Harrison, R. S.: The Radiation Therapy of Actinomycosis, Brit. J. Radiol. **7**: 98-110, 1934.
66. Harsha, W. M.: Actinomycosis of the Jaw, Ann. Surg. **39**: 459-460, 1904.
67. Harz: Actinomyces bovis, ein neuer Schimmel in dem Gewebe des Rindes, Jahresber d. konigl. Central-Thierarzneischule zu Munchen, 1877 (cited by Cope[31]).
68. Heeren, J.: Zur Bestrahlungstecknik der Aktinomykose, Röntgenpraxis **1**: 475-491, 1929.
69. Hendrickson, G. G., and Lehman, E. P.: Cervicofacial Actinomycosis Successfully Treated by Penicillin Without Surgical Drainage, J. A. M. A. **128**: 438, 1945.
70. Henkel, K.: Die Behandlung der Aktinomykose, Therap. d. Gegenw. **82**: 171-173, 1941.
71. Henrici, A. T.: Molds, Yeasts and Actinomycetes, New York, 1930, John Wiley & Sons, Inc.
72. Henrici, A. T., and Reynolds, G. S.: KI Does Not Influence the Course of Experimental Actinomycosis, Proc. Soc. Exper. Biol. & Med. **19**: 255-256, 1922.
73. Herrell, W. E.: The Clinical Use of Penicillin, J. A. M. A. **124**: 622-627, 1944.
74. Herrell, W. E.: Penicillin and Other Antibiotic Agents, Philadelphia, 1945, W. B. Saunders Company.
75. Herrell, W. E., Nichols, D. R., and Heilman, D. H.: Penicillin, J. A. M. A. **125**: 103-111, 1944.
76. Heyerdahl, S. A.: Einige Falle von Aktinomykose geheilt mit Radium, Zentralbl. f. Chir. **43**: 894, 1916.
77. Heyerdahl, S. A.: Actinomycosis Treated With Radium, J. A. M. A. **73**: 1928-1929, 1919.
78. Heyerdahl, S. A.: Uber die Radium behandlung der Aktinomykose des Gesichts und des Halses, Strahlentherapie **25**: 679-691, 1927.
79. Haldre, J., and Koskvee, L.: Beitrag zur Rontgenbehandlung der Aktinomykose, Röntgenpraxis **12**: 228-232, 1940.
80. Hollenbeck, W. F., and Turnoff, D.: Actinomycosis Treated With Sulfadiazine, J. A. M. A. **123**: 1115-1116, 1943.
81. Hudson, R. V.: Discussion, Lancet **2**: 639, 1943.

82. Israel, J.: Neue Beobachtungen auf dem Gebiete der Mykosen des Menschen, Arch. f. path. Anat., Berl. **74**: 15-53, 1878.
83. Israel, J.: 1885, cited by Cope.[31]
84. Itterson and Netter: Cited by Henkel.[70]
85. Jones, T. E., and Brownell, T. S.: Treatment of Actinomycosis With Penicillin, Cleveland Clin. Quart. **12**: 32-33, 1945.
86. Joyce, T. M.: Thymol Therapy in Actinomycosis, Ann. Surg. **108**: 910-915, 1938.
87. Jungling, O.: Zur Röntgenbehandlung der Aktinomykose, Beitr. z. klin. Chir. **118**: 105-125, 1920.
88. Kaplan, I. I.: Ein seltener Fall von Aktinomykose Appendicitis, Arch. f. klin. Chir. **128**: 410-416, 1924.
89. Kay, E. B., and Meade, R. H.: Penicillin in the Treatment of Chronic Infections of the Lungs and Bronchi, J. A. M. A. **129**: 200-204, 1945.
90. Keefer, C. S., and others: Penicillin in the Treatment of Infections, J. A. M. A. **122**: 1217-1224, 1943.
91. Keeney, E. L., Ajello, L., and Lankford, E.: Studies on Common Pathogenic Fungi and on Actinomyces bovis: III. In Vitro Effect of Penicillin, Bull. Johns Hopkins Hosp. **75**: 410-416, 1944.
92. Keijser, S.: Rontgenbehandlung der Aktinomykose, Strahlentherapie **56**: 449-455, 1936.
93. Kirklin, B. R., and Hefke, H. W.: The Roentgenologic Aspects of Actinomycosis of the Lungs, Am. J. Surg. **13**: 1-8, 1931.
94. Kleesattel, H.: Zur Frage der Röntgenemfindlichkeit des Strahlenpilzes, Strahlentherapie **17**: 390-394, 1924.
95. Kolmer, J. A.: Penicillin Therapy, New York, 1945, D. Appleton-Century Company, Inc.
96. Kuhlmann, B.: Zur Prognose der Röntgentherapie der Lungenaktinomykose, Strahlentherapie **60**: 476-482, 1937.
97. Ladd, W. E., and Bill, A. H.: Actinomycosis of the Chest With Spread to the Abdomen, New England J. Med. **229**: 748-750, 1943.
98. Levy, B. R.: Röntgenbestrahlung der Aktinomykose, Zentralbl. f. Chir. **40**: 121-122, 1913.
99. Lignieres, J., and Spitz, G.: Actinobacillosis, Semana méd. **9**: 207-215, 1902.
100. Lord, F. T.: The Etiology of Actinomycosis: The Presence of Actinomycetes in the Contents of Carious Teeth and the Tonsillar Crypts of Patients Without Actinomycosis, J. A. M. A. **55**: 1261-1263, 1910.
101. Lord, F. T.: A Contribution to the Etiology of Actinomycosis: the Experimental Production of Actinomycosis in Guinea Pigs, Boston M. & S. J. **163**: 82-85, 1910.
102. Lord, F. T., and Trevett, L. D.: The Pathogenesis of Actinomycosis, J. Infect. Dis. **58**: 115-120, 1936.
103. Lyons, C.: Penicillin Therapy of Surgical Infections in the U. S. Army, J. A. M. A. **123**: 1007-1018, 1943.
104. Lyons, C., Owen, C. R., and Ayers, W. B.: Sulfonamide Therapy in Actinomycotic Infections, SURGERY **14**: 99-104, 1943.
105. MacCharles, M. R., and Kippen, J. W.: Three Cases of Actinomycosis Treated With Sulphanilamide, Canad. M. A. J. **41**: 490-491, 1939.
106. McCallem, A. I.: Actinomycotic Infection, With Case Reports, Canad. M. A. J. **9**: 411-420, 1919.
107. McCloy, A.: Actinomycosis of the Tongue Successfully Treated by Sulphonamides, Brit. M. J. **2**: 106, 1943.
108. McCrea, J. H., Stevens, R. A., and Williams, O. O.: Actinomycotic Infection of the Soft Tissues of the Neck, J. Lab. & Clin. Med. **30**: 509-511, 1945.
109. McKenty, F. L.: A Study of Cases of Actinomycosis, Am. J. M. Sc. **145**: 835-857, 1913.
110. McWhirter, R.: Radiotherapeutic Treatment of Certain Granulomata, Brit. J. Radiol. **11**: 664-670, 1938.
111. Magnusson, H.: The Commonest Forms of Actinomycosis in Domestic Animals and Their Etiology, Acta path. et microbiol. Scandinav. **5**: 170-245, 1928.
112. Magrou, J. E.: Les grains botryomycotiques, Thesis 267, Paris, 1914 (cited by Cope[31]).
113. Nat. Res. Council: Manual of Clinical Mycology, Philadelphia, 1945, W. B. Saunders Company.
114. Martin, C. J.: Die Röntgentherapie der Aktinomykose, Strahlentherapie **56**: 650-659, 1936.
115. Masson, D. M.: Abdominal Actinomycosis: Report of Two Cases With Clinical Cure, Proc. Staff Meet., Mayo Clin. **11**: 833-836, 1936.
116. Mathieson, D. R., Harrison, R., Hammond, C., and Henrici, A. T.: Allergic Reactions of Actinomycetes, Am. J. Hyg. **21**: 405-421, 1935.

117. Matz, F.: Eine seltene Netzgeschwulst (Aktinomykom), Deutsche Ztschr. f. Chir. **176**: 217-222, 1922.
118. Melchior, E.: Klinische Erfahrungen über Kombinierte Jod Röntgentherapie der cervico-facialen Aktinomykose, Berl. klin. Wchnschr. **53**: 586-587, 1916.
119. Meleney, F. L.: Recent Experiences With Penicillin in the Treatment of Surgical Infections, Bull. New York Acad. Med. **20**: 517-537, 1944.
120. Miller, E. M., and Fell, E. H.: Sulfanilamide Therapy in Actinomycosis, J. A. M. A. **112**: 731, 1939.
121. Mitchell, H. S.: Sulfapyridine in Actinomycosis, Canad. M. A. J. **46**: 584, 1942.
122. Moene, I.: Behandlung av Aktinomykose, Nord. Med. **5**: 335-337, 1940.
123. Morton, H. S.: Actinomycosis, Canad. M. A. J. **42**: 231-236, 1940.
124. Myers, H. B.: Thymol Therapy in Actinomycosis, J. A. M. A. **108**: 1875, 1937.
125. Myers, H. B.: An Unappreciated Fungicidal Action of Certain Volatile Oils, J. A. M. A. **89**: 1834-1837, 1927.
126. Myers, H. B., and Thienes, C. H.: The Fungicidal Activity of Certain Volatile Oils and Stearoptens, J. A. M. A. **84**: 1985-1987, 1927.
127. Naeslund, C.: Experimentelle Studien über die Aetiologie und Pathogenese der Aktinomykose, Acta path. et microbiol. Scandinav. **8**: (Supplement 6), 1-156, 1931.
128. Naussac, J.: The Pathology, Symptomatology and Differential Diagnosis of Pulmonary Actinomycosis, Internat. Clin. **3**: 1-18, 1921.
129. Neuber, E.: Spezifische Diagnostik and Therapie der Aktinomykose, Klin. Wchnschr. **19**: 736-741, 1940.
130. New, G. B., and Figi, F. A.: Actinomycosis of the Head and Neck; a Report of 107 Cases, Surg., Gynec. & Obst. **37**: 617-625, 1923.
131. Nocard, E.: Revue de Med. Vet., 1893 (cited by Colebrook[29]).
132. Nordentoft, J.: Several Cases of Actinomycosis With Reference to Experiments in X-ray Treatment, Nord. Tidsskr. f. Terapi Køpenh. **12**: 272-276, 1914.
133. Northrop, P. M., and Crowley, M. C.: The Prophylactic Use of Sulfathiazole in Transient Bacteremia Following the Extraction of Teeth, J. Oral Surg. **1**: 19-21, 1943.
134. Ochsner, A. J.: Actinomycosis of the Colon, Surg. Clin., Chicago, December, 1203, 1917.
135. Ogilvie, W. H.: Abdominal Actinomycosis Treated With Sulfapyridine, Brit. M. J. **2**: 254-255, 1940.
136. Orr, T. G.: Actinomycoma of the Third Ventricle, Probably Primary, J. A. M. A. **127**: 757-758, 1945.
137. Pillsbury, N. R., and Wassersug, J. D.: Pulmonary Actinomycosis: Treatment With Sulfonamides, New England J. Med. **230**: 72-74, 1944.
138. Ponfick: Die Aktinomykose des Menschen, Berlin, 1882 (cited by Cope[31]).
139. Pope, E. L.: Actinomycosis: An Analysis of 12 Cases, Canad. M. A. J. **32**: 542-545, 1935.
140. Poulton, E. P.: Discussion on the Treatment of Bacterial Diseases With Substances Related to Sulphanilamide, Proc. Roy. Soc. Med. **31**: 149-166, 1938.
141. Prikul, A.: Treatment of Actinomycosis, Deutsche Ztschr. f. Chir. **166**: 414, 1921, abstracted in J. A. M. A. **77**: 1932.
142. Ramstad, N. O.: Actinomycosis, Journal-Lancet **36**: 732-735, 1916.
143. Randall, O. S.: Actinomycosis, Staff Bull. U. of Minn. Hosp. **5**: 237-250, 1934.
144. Randall, O. S.: The Early Diagnosis and Surgical Treatment of Actinomycosis of the Head and Neck, Am. J. Surg. **57**: 433-443, 1942.
145. Renander, A.: Le Traitement Radiologique de L'actinomycose Acta radiol. **35**: 1-75, 1936.
146. Roberts, J. E. H., Tubbs, O. S., and Bates, M.: Pleural and Pulmonary Suppuration Treated With Penicillin, Lancet **1**: 39-45, 1945.
147. Robinson, R. A.: Actinomycosis of the Subcutaneous Tissue of the Forearm Secondary to a Human Bite, J. A. M. A. **124**: 1049-1051, 1944.
148. Rosebury, T.: The Parasitic Actinomycetes and Other Filamentous Micro-organisms of the Mouth, Bact. Rev. **8**: 189-223, 1944.
149. Rosebury, T., Epps, L. J., and Clark, A. R.: A Study of the Isolation, Cultivation and Pathogenicity of Actinomyces Israelia Recovered From the Human Mouth and From Actinomycosis in Man, J. Infect. Dis. **74**: 131-149, 1944.
150. Sanford, A. H.: The Distribution of Actinomycosis in the U. S., J. A. M. A. **81**: 655-659, 1923.
151. Sanford, A. H., and Voelker, M.: Actinomycosis in the U. S., Arch. Surg. **11**: 809-841, 1925.
152. Sardemann, E.: Ueber die Behandlung der Aktinomykose mit Röntgenstrahlen, Beitr. z. klin. Chir. **90**: 157-167, 1914.
153. Sattler, E.: Ueber die Bauchaktinomykose, Wien. klin, Wchnschr. **36**: 714-715, 1923.
154. Schmidt, H. E.: Röntgen-Therapie, Berlin, 1920.

155. Schmitt, S. F., and Olson, A. M.: Actinomycosis of the Thorax: Report of Two Cases, Proc. Staff Meet., Mayo Clinic **16**: 506-509, 1941.
156. Schuchardt, K.: Zur Vaccinetherapie der Aktinomykose, Arch. f. klin. Chir. **196**: 656-661, 1939.
157. Selbie, F. R., Simon, R. D., and McIntosh, J.: Bacteriologic Aspects of Penicillin Therapy, J. Path. & Bact. **57**: 47-58, 1945.
158. Shahan, M. S., and Davis, C. L.: The Diagnosis of Actinomycosis and Actinobacillosis, Am. J. Vet. Research **3**: 321-328, 1942.
159. Slack, J.: The Source of Infection in Actinomycosis, J. Bact. **43**: 193-209, 1942.
160. Smith, E. G.: Roentgen Therapy of Actinomycosis, Am. J. Roentgenol. **31**: 823-829, 1934.
161. Smith, F. L.: Postoperative Treatment of Abdominal Actinomycosis, S. Clin. North America **10**: 171-174, 1930.
162. Starlinger, F.: Berichte aus den wissenschafflichen Vereinen—Aktinomykose der Bauchhöhle, Wien. med. Wchnschr. **88**: 159, 1938.
163. Steinkamm, J.: Die Strahlenbehandlung der Aktinomykose, Strahlentherapie **12**: 512-516, 1921.
164. Stocker, H.: Die Behandlung der Aktinomykose und ihre Resultate, Deutsche Ztschr. f. Chir. **230**: 169-181, 1931.
165. Sudler, M. T., and Johnson, C. B.: Treatment of Actinomycosis With Sulfanilamide: Report of Two Cases, J. Kansas M. Soc. **40**: 330, 1939.
166. Sullivan H. H., and Goldsworthy, N. E.: A Comparative Study of Anaerobic Strains of Actinomyces From Clinically Normal Mouths and From Actinomycotic Lesions, J. Path. & Bact. **51**: 253-261, 1940.
167. v. Tempsky, A.: Resultate der Roentgentherapie bei der Strahlenpilzerkrankung, Beitr. z. klin. Chir. **139**: 207-216, 1927.
168. Thomassen: cited by Colebrook.[29]
169. Topley, W. W. C., and Wilson, G. S.: The Principles of Bacteriology and Immunity, ed. 2, Baltimore, 1938, William Wood & Company.
170. Von Baracz, R.: Die Behandlung der Aktinomykose mit Kupfersulfat auf Grund einer 19 Jahrigen Erfolgung, Zentralb. f. Chir. **49**: 634-639, 1922.
171. Wakeley, C. P. G.: The Treatment of Actinomycosis by X-rays With a Report of 9 Cases, Arch. Radiol. & Electroth. **28**: 129-135, 1923.
172. Waksman, S. A.: On the Classification of Actinomycetes, J. Bact. **39**: 549-558, 1940.
173. Waksman, S. A., and Henrici, A. T.: The Nomenclature and Classification of the Actinomycetes, J. Bact. **46**: 337-341, 1943.
174. Waksman, S. A., and Woodruff, H. B.: Selective Antibiotic Action of Various Substances of Microbial Origin, J. Bact. **44**: 373-384, 1942.
175. Walker, O.: Sulfanilamide in the Treatment of Actinomycosis, Lancet **1**: 1219-1220, 1937.
176. Walker, J. M., and Hamilton, J. W.: The Treatment of Actinomycosis With Penicillin, Ann. Surg. **121**: 373-384, 1945.
177. Wangensteen, O. H.: Actinomycosis of the Thorax: Report of a Case Successfully Operated Upon, J. Thoracic Surg. **1**: 612-636, 1932.
178. Wangensteen, O. H.: The Role of Surgery in the Treatment of Actinomycosis, Ann. Surg. **104**: 752-770, 1936.
179. Waring, H. J.: Actinomycosis of the Cecum, Vermiform Appendix and Right Iliac Fossa, St. Barth. Hosp. Rep., Lond. **41**: 197-210, 1905.
180. Weysser, C.: Heilung einer Frau mit Bauchaktinomykose durch fraktionierte Roentgenbestrahlung, Strahlentherapie **58**: 234-237, 1937.
181. Wilkinson, E. E.: Actinomycosis Treated With Sulfanilamide, J. Pediat. **18**: 805-810, 1941.
182. Wolff, M., and Israel, J.: Ueber Reincultur des Actinomyces und seine Uebertragbarkeit auf Thiere, Virchow's Arch. f. path. Anat. [etc.], Berl. **126**: 11-59, 1891.
183. Wollgast, C. F.: The Clinical Use of Penicillin, Report of 115 Cases Treated in Army Hospital, Texas State J. Med. **40**: 225-230, 1944.
184. Woodman, T. W.: Abdominal Actinomycosis, Southwestern Med. **25**: 81-83, 1941.
185. Wright, J. H.: The Biology of the Micro-Organism of Actinomycosis, J. Med. Research, Boston **13**: 349-404, 1905.
186. Wynn, W. H.: A Case of Actinomycosis of the Lung and Liver Successfully Treated With a Vaccine, Brit. M. J. **1**: 554-557, 1908.
187. Ziskin, D. E., Shoham, J., and Hanford, J. M.: Actinomycosis: A Report of 26 Cases, Am. J. Orthodontics **29**: 193-201, 1943.

# Review of Recent Meetings

## MEETING OF THE AMERICAN SURGICAL ASSOCIATION

HOT SPRINGS, VA., APRIL 2-5, 1946

J. DEWEY BISGARD, M.D., OMAHA, NEB.

**Address of the President, William Darrach,** New York.—In the treatment of fractures there are five objectives: (1) Reduction of secondary trauma to a minimum. Often damage to soft tissues is the major casualty, as a transverse myelitis in fractures of the spine. It is minimized by proper splinting and handling during transportation from site of injury and judicious manipulation in reduction and subsequent treatment. (2) Reduction should be accomplished by the simplest and safest methods necessary to obtain an optimal result. This may be short of the ideal anatomic reduction. (3) Immobilization should be rigid with few exceptions, such as the hanging cast for fractures of the humerus, and it should allow maximum ambulation. (4) Restoration of function should be accomplished as early and rapidly as possible and disuse atrophy minimized by the earliest institution of active motion. (5) Morale and physical and social rehabilitation are important problems in patients with prolonged or permanent major disabilities. For the first time in history, patients with paraplegia from among the wounded of World War II have been made ambulant by skillful psychologic handling and physical training. Compensation insurance relieves many of the injured of personal responsibility and thereby prolongs disability.

In the treatment of compound fractures the early and thorough débridement of the wound is most important. Chemotherapy has a secondary but invaluable place. The question of primary or secondary closure of the wound must be individualized, but in general early secondary closure is safer.

**Pharyngoesophageal Diverticulum: Its Management and Complications, Frank H. Lahey,** Boston.—Reported were 202 cases in which operation was done, with one death resulting from leakage from an unobserved perforation of the sac accidentally created during dissection in the first stage of a two-stage operation.

The three stages in the development of diverticula were illustrated. Until obstruction develops in the third stage there are either no symptoms or there is merely a sense of pressure or tickling in the throat and the unpleasant sound of air regurgitating from the sac.

Incomplete dissection of the sac results in its inadequate removal and likelihood of recurrence. Wide exposure of the esophagus is necessary to avoid the danger of stricture from too extensive an excision.

A case illustrating the occasional occurrence of carcinoma in the sac was presented.

**Diverticula of the Thoracic Esophagus, Robert M. Janes,** Toronto.—Six cases were reported. Four patients were operated upon through a posterior lateral incision through the bed of the seventh rib and all were relieved of symptoms. Special care consisted of preoperative cleansing of the esophagus by lavage and postoperative feeding through a duodenal tube.

The sac was excised and the esophagus sutured in layers with a closed aseptic technique.

Since the mouths of the sacs are wide, there is usually little or no retention. Symptoms consist of periodic episodes of subxiphoid or subscapular pain, a sense of food sticking, and occasionally regurgitation.

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In the discussion of the papers by Lahey and Janes, **S. W. Harrington,** Rochester, Minn., reported 187 pharyngoesophageal diverticula, most of them operated in a single stage; also four diverticula of the thoracic esophagus. **Robert Dinsmore,** Cleveland, reported a case in which spontaneous perforation had occurred with mediastinal abscess. Preliminary drainage and four subsequent operations were required to eradicate the diverticulum and cure the patient. **Lahey** reported five cases of diverticulum of the thoracic esophagus and described a method in which the sac is dissected free and the fundus inverted and sutured to the mediastinal pleura so that it is proximal to the mouth, discouraging the entrance of food and promoting drainage.

**Bronchiogenic Carcinoma, Gustaf E. Lindskog,** New Haven. In 100 consecutive cases of primary lung cancer, the average case age was 55 years. The duration of symptoms in the entire group was 7.7 months; in the presumably operable (exploration) group, 7.0 months; in the resected group, 7.4 months; all of which suggests that duration is of less importance than other factors, such as degree of malignancy and location of the tumor.

Positive tissue diagnosis was made in 73 cases before death by means of bronchoscopy, aspiration, and cells in sputum and pleural fluid. Thirty carcinomas (30 per cent) were presumed to be operable. Of the 30 explorations, 11 proved to be resectable (pneumonectomy 9, lobectomy 2). Of the fatal cases, 36 patients received no special treatment and lived an average of 6.0 months. Of 34 who received deep roentgen therapy, the average duration of life was 7.4 months; of 11 who had exploratory thoracotomy alone, 7.6 months; of 7 who died of recurrence or metastasis following operation, 7.4 months.

In the discussion **Evarts Graham,** St. Louis, reported six patients living and well eight years after total pneumonectomy. In a recent series of 246 cases only 18 per cent were resectable. In 80 per cent the diagnosis was established by bronchoscopic examination. **Alton Ochsner,** New Orelans, reported 260 cases; exploration was done in 172 and resection in 28 per cent with 10 per cent mortality. He believes palliative resection is justifiable. **Carl Eggers,** New York, reported a series in which exploration was done in 35 cases and of these pneumonectomy was performed in 15 cases and lobectomy in 1. Seven are living and well one to eight years following operation.

**Carcinoma of the Mid-Thoracic Esophagus: Its Treatment by Radical Resection and High Intrathoracic Esophagogastric Anastomosis, Richard H. Sweet,** Boston.—Reported were thirty-two cases of carcinoma of the middle one-third of the esophagus in which alimentary continuity following resection of the tumor along with the esophagus distal to it was re-established by direct anastomosis to the stomach. The stomach was mobilized by the division of left gastric artery and as much of its mesenteries and other vessels as needed to gain approximation without tension with the proximal severed end of the esophagus. In some of the cases the stomach was anastomosed at a level above the arch of the aorta. Of the thirty-two cases there were eight hospital deaths.

In discussion **Harold Wookey,** Toronto, stated that he had found that transplantation of the esophagus anterior to the aorta facilitated the anastomosis and **Frederick L. Reichert,** San Francisco, stated that additional length of stomach could be gained by mobilizing the duodenum.

**Studies on the Use of Gelatin Sponge or Foam as a Hemostatic Agent, Hilger P. Jenkins** and (by invitation) **Rudolph Janda,** Chicago.—In a series of forty dogs in which the gelatin sponge was used to control bleeding from wounds of the liver or spleen it was found that satisfactory hemostasis was obtained by pressing the gelatin sponge wet with saline into the wound and maintaining gentle pressure for about three minutes. There did not appear to be any substantial increase in the effectiveness of the gelatin sponge in controlling bleeding when the sponge was soaked in thrombin solution. In thirty-five operations on patients the gelatin sponge was effective. There were no difficulties encountered from the standpoint of infection or delay in wound healing. Under favorable conditions the sponge was found to undergo absorption over a period of about one month. In the presence of a conspicuous leucocytic response it was found to undergo liquefaction in a few days to a

week. Gelatin sponge is a valuable absorbable hemostatic agent which compares favorably with soluble cellulose and fibrin foam.

In discussion **W. Jason Mixter,** Boston, commented that at reoperation for neurosurgical lesions he found that gelatin sponges or fibrin foam used for hemostasis at the first operation had left smooth surfaces and a better line of cleavage than muscle and other hemostatic agents.

**Studies on the Effects of Adult Tissue Extracts on Wound Healing With a Preliminary Report of Investigations of the Factors Responsible, William Andrus** and (by invitation) **R. S. Hoffman** and **James A. Dingwall,** New York.—Tyrode extract of adult animal tissue has been shown to have an accelerating effect on the growth of fibroblasts and epithelial cells in vitro far beyond that to be expected from the nutrient content of the extract. This effect is neither organ nor species specific and has been confirmed in a controlled series of experimental wounds in animals as well as in refractory wounds in patients.

**Tetanus in the Battle for Manila** (1945). **An Experience Amongst the Civilian Casualties, Frank Glenn,** New York.—Over 500 cases of tetanus occurred in approximately 12,000 civilian casualties from the Battle for Manila; 389 died, a mortality of 80 per cent. When well established, no form of treatment of the disease was effective. In the United States Army there were only eleven cases of tetanus and four of these were fatal. Two of the patients who died had been immunized but had received no booster shots.

In discussion **Edward Churchill,** Boston, stated that the majority of the German soldiers had not been immunized and many died from tetanus. **Warfield M. Firor,** Baltimore, emphasized the ineffectiveness of the known forms of treatment for the advanced and severe cases, and also commented that the cause of death was incompletely understood.

**A Systematic Study of Penicillin in the Treatment of Established Surgical Infections, Frank L. Meleney,** New York.—From a study of established surgical infections by the Sub-Committee on Infected Wounds and Burns of the National Research Council the following conclusions were drawn. Penicillin is a very effective antibacterial agent; it is effective in two-thirds of infections when used either alone or in conjunction with such surgical practices as drainage. It is more effective in acute infection but less effective in mixed infection. Some bacteria are indifferent and some antagonistic to penicillin, such as the colon flora, some of subtilis and saprophytic groups. These groups produce penicillinase. Streptothricin, streptomycin, sulfonamide drugs, and other agents are helpful in ridding the wound of these, the penicillin antagonists. For this reason treatment of infected wounds should be controlled by frequent cultures.

In discussion **John S. Lockwood,** New Haven, stated that there are four known types of penicillin. Penicillin K is ineffective because it is eliminated very rapidly. Commercial products have varied much in effectiveness as the result of the relative proportion of the various types. **Jonathan E. Rhoads,** Philadelphia, stated that peritonitis in dogs responds more effectively to treatment with sulfonamide drugs than penicillin and best with the simultaneous administration of both drugs.

**A Quantitative Study of the Anemia Following Burns, Oliver Cope,** and (by invitation) **Francis D. Moore,** Boston.—By means of tagged or radioactive red cells to quantitate the circulating blood, it was demonstrated that severely and deeply burned patients may destroy 100 to 200 c.c. of red blood cells per day in the first three or four days after burning, and that somewhat later the patients may develop a red cell disappearance which is probably a result of malnutrition and wound infection. In these cases transfused red cells show the same rapid loss. Some factor causing an increase of fragility is a probable explanation. Some marrow depression is an additional contributing factor to the anemia. Early covering of surfaces with skin grafts stops the loss of red cells.

**Studies on Water-Soluble Vitamins in Burns and Other Severe Trauma, C. C. Lund,** and (by invitation) **S. M. Levenson, R. W. Green, J. Lewis, C. S. Davidson, R. E. Johnson,** and **F. H. L. Taylor,** Boston.—Of fifty patients with burns and ten patients with various severe injuries, it was observed that zero levels of vitamin C may be found in the blood

and abnormally low levels of excretion of vitamin C, of thiamin, of riboflavin, and of n-methyl-nicotinamide may be found in the urine shortly after burns and injuries. Unless large doses of these vitamins are given, deficiency states interfering with recovery and healing arise. In severe burns and injuries full saturation cannot be maintained unless huge doses are given.

**The Pyruvic Acid Method in the Local Treatment of Clinical Deep Burns, Samuel C. Harvey** and (by invitation) **Gervase J. Connor,** New Haven.—The application of pyruvic acid with a pH of 1.9 in a cornstarch paste causes rapid separation of the slough of a deep thermal burn without significant damage to the living tissue, and the wound is immediately acceptable for extensive skin grafting regardless of the presence of bacteria on its surface. Thus the ultimate objective of local treatment in deep burns, namely the early closure of the wound, can be speedily achieved. An experience with thirty cases was reported and in some the sloughs had separated and surfaces had been grafted within ten days after burning.

**Fractures of the Os Calcis, R. I. Harris,** Toronto.—Fracture of the os calcis occurred frequently during World War II as a result of injury from land and sea mines and torpedoes. Permanent disablement to some degree is a frequent result because the fracture usually involves the posterior articular facet, and the comminution of the bone often causes considerable deprivation of the blood supply of some of the fragments, which may undergo aseptic necrosis with loss of cartilage and ultimately traumatic osteoarthritis—no matter how perfect the reduction.

A special apparatus was presented for reduction of the fracture, devised by the author. Reduction is supervised with radiographs and after forty-eight hours a plaster cast is applied incorporating the pins in the os calcis and in the tibia, which were used for traction and counter-traction in the reduction.

In cases in which permanent disability is anticipated, despite reduction, early fusion of the subastragalar joint should be done. The Gallie technique through a posterior approach was described. The author reported thirty-five patients back at work six months after injury.

In discussion **Kellog Speed,** Chicago, warned that since the bone is spongy in type and the fracture is comminuted, some crushing down under weight-bearing may take place if permitted too early.

**Management and Rehabilitation of Naval Battle Casualty Amputees, Waltman Walter,** Captain, M.C., U.S.N.R. and (by invitation) **Theodore E. Orr,** Captain, M.C., U.S.N.R., **Donald T. Jones,** Commander, M.C., U.S.N.R., **Thomas C. Ryan,** Commander, M.C., U.S.N., and **William L. White,** Lieutenant (j.g.), M.C., U.S.N.R.—In the majority of cases secondary plastic closures were done, including revisions, reamputations, and skin grafts. The group of open-flap amputations, well maintained with traction required fewer secondary operations than the guillotine group. For treatment of the open stump best results were obtained by streptomycin, penicillin, zinc peroxide, hypertonic saline solution, and Castellani's paint. Streptomycin was very effective in controlling saprophytic infections. The program of rehabilitation was described.

In discussion **N. T. Kirk,** Major General, U. S. Army, stated that if properly performed a guillotine amputation provided adequate flaps for secondary closure and that only pedicle grafts gave satisfactory covering on stumps.

**The New Viewpoint Toward Spinal Cord Injuries, Robert H. Kennedy,** New York.—Until World War II, 80 per cent of traumatic paraplegics died within a few months, most of them from urinary infections and decubitus ulcers. In the Army there were approximately 1,400 cases with cord injuries and the majority of the patients not only will live but will be ambulatory. With tidal irrigation and chemotherapy most of them escaped infection and regained satisfactory bladder control. By maintaining the pH of the urine around 4.5 the incidence of calculi was reduced. Large decubitus ulcers occurred in 70

per cent of the injuries and early surgical flap closure of these hastened ambulation and caused nutrition to improve. The most important progress in the care of these patients has been in the psychologic readjustment and ambulation accomplished by the patient skilled workers in these fields.

One-third of the cases have much pain and in 10 per cent it is severe enough to require surgical relief.

In discussion **Loyal Davis,** Chicago, stated that these patients would require much nursing care and many of them permanent hospitalization. **Howard Naffzinger,** San Francisco, cited patients who had returned to sedentary but useful occupations. **W. Jason Mixter,** Boston, stated that in the permanently spastic cases section of the anterior roots was indicated.

**Results in the Surgical Treatment of Ruptured Discs, Francis C. Grant,** Philadelphia.—In a series of 175 patients operated upon for ruptured intravertebral disc, only 56 per cent of those classified as laborers and 68 per cent as nonlaborers were relieved of symptoms. In a control series of about 100 unoperated cases, 48 per cent were relieved with conservative treatment. In 98 per cent of the cases with complete rupture and protrusion of the disc, relief followed operation. The failures occurred in the group in which there was no protrusion of the disc.

In discussion **W. Jason Mixter,** Boston, raised the question of method of determining those patients who should have spinal fusion. **George Bennett,** Baltimore, expressed the opinion that complementary fusion should be done if there is much back pain and abnormal mobility of the vertebrae. **James C. White,** Captain, M.C., U.S.N.R., reported twenty-three patients operated upon and followed for six months in the service. Seventy per cent had returned to duty. There was one failure later relieved by fusion and two recurrences. All presented positive myelographic evidence of herniated disc. **Philip Wilson,** New York, expressed the opinion that after operation myelograms are deceptive and that in the absence of bulging of the disc simultaneous fusion should be done. **Max M. Peet,** Ann Arbor, stated that he had discontinued myelography in disc cases because it was untrustworthy.

**Subtotal Gastrectomy for Duodenal Ulcer; A Report of Personal Experiences, Arthur W. Allen** and (by invitation) **Claude E. Welch,** Boston.—Reported were the results of subtotal gastrectomy in 200 cases of duodenal ulcers unresponsive to medical therapy with a mortality less than 2 per cent. The principal hazard and source of mortality, leakage from the duodenal stump, was eliminated by utilizing the Bancroft-Finster operation in cases in which difficulty in mobilizing and closing the duodenal stump was anticipated. In some cases the stomach was bisected through the pyloric end to facilitate dissection of the duodenum from the pancreas. Most of the lesser curvature was included in the resections. The frequent occurrence of dizziness, faintness, and failure to gain weight was mentioned.

In discussion **Lester Dragstedt,** Chicago, reported that during the past three years he had done vagus section in sixty-seven cases of duodenal ulcer with complete relief of symptoms in essentially all cases. **Roscoe Graham,** Toronto, stated that patients in whom the proximal loop of the jejunum had been lifted by suturing it to the lesser curvature suture line (Hofmeister type operation) suffered fewer sensations of faintness. **Frank H. Lahey,** Boston, referred to a publication in which he had stressed the necessity of exposing the common duct before mobilizing the duodenum when dissection must be carried in close proximity to the duct. In some cases he places a T tube into the duct to aid in identifying it.

**Definitive Surgery of the Large Intestine Following War Wounds, Clyde O. Barney,** Colonel, and **Louis C. Roettig,** Major, M.C., A.U.S. (by invitation of the program committee).—During World War II, soldiers sustaining abdominal wounds involving the colon had temporary colostomies performed, exteriorizing the site of injury, or proximal thereto. The mortality in those so injured was probably one-third that of World War I. Due to the extensive nature of their injuries, many men returned to the United States for definitive surgery including closure of colostomy. One hundred eight cases with various types of

damage to the colon, rectum, and adjacent structures were reviewed and the respective surgical procedures discussed. Colostomy closure was performed by intraperitoneal anastomosis. Colon resections were performed in one stage. In both procedures an open anastomosis technique was used. Patient's preoperative preparation included sulfaguanidine and thorough daily irrigation of the colon.

No fatalities occurred in this series. Three patients developed fecal fistulas, two of which closed spontaneously. All patients were discharged with satisfactory bowel function.

**Congenital Hypertrophic Pyloric Stenosis, Edward J. Donovan,** New York.—Reported were 507 cases of hypertrophic pyloric stenosis with two deaths. Low mortality was attributed to earlier operations and proper preoperative preparation with glucose and adequate hydration. Reported were two young adults who had had gastroenterostomies in infancy for hypertrophic pyloric stenosis. In both cases the hypertrophic ring at the pylorus was still present and obstructing.

In discussion **William E. Ladd,** Boston, reported 225 patients operated upon in the past three years with no deaths. He warned of the danger of pulmonary edema from overhydration and recommended a high right gridiron incision.

**Diverticulitis of the Colon, John Morton,** Rochester, N. Y.—The report consisted of 110 cases of diverticulitis with spasm of the bowel only and 85 cases with complications, consisting of perforation with peritonitis and local abscess, cutaneous and vesical fistulas, and sinus formation and obstruction. In the first group the presence of spasm was demonstrated radiographically. Gross bleeding occurred in 20 per cent of the cases. Operative treatment of the patients with complications consisted of proximal colostomy, resection, and drainage of abscesses.

In the discussion **Carl Eggers,** New York, reported 108 cases of which 63 were uncomplicated and 25 had perforated, two into the bladder. Forty-three patients were operated upon and in 12 resections were done. **Harvey B. Stone,** Baltimore, reported two cases illustrative of impending perforation into the bladder. In both cases there was the sudden onset of frequency and dysuria and vesical fistula was prevented by immediate operation. **Vernon C. David,** Chicago, spoke of the occasional complication of pyelophlebitis with liver abscess and warned that carcinoma must be excluded before bleeding can be attributed to diverticulitis. **Damon B. Pfeiffer,** Philadelphia, reported the occurrence of massive hemorrhage in diverticulitis.

**Late Results in the Treatment of Ulcerative Colitis, Henry W. Cave,** New York.—The results of operative therapy in 101 cases of ulcerative colitis were reported. In 71 cases ileostomies had been performed, in 63 subtotal colectomies, in 9 partial colectomies, and in 11 the rectum was also removed. Ninety-five per cent of the survivors regained weight and good health in addition to relief from symptoms and endured the ileostomy with good mental outlook. In 3 cases carcinoma developed in inflammatory polyps. Excoriation of the skin about the ileostomy can be prevented by use of fullers' earth and a special bag.

The complications have been intestinal obstruction, prolapse of the ileal stoma, malnutrition, and arthritis.

**Richard B. Cattell,** Boston, described a method he had used to prevent prolapse, consisting of widely anchoring the mesentery to the parietal peritoneum. **Harvey B. Stone,** Baltimore, referred to a method for preventing prolapse which he had reported. It consists of side-to-side anastomosis of the proximal and distal loops to form a common pouch just under the peritoneum. **James D. Rives,** New Orleans, spoke of a group of patients who are not benefited by ileostomy or colectomy. All are women and in all of them the bowel is normal in appearance.

**Palliative Gastrectomy in Selected Cases of Gastric Ulcer, Ralph Colp** and (by invitation) **Leonard Druckerman,** New York.—Eight cases were reported with chronic gastric ulcers high on the lesser curvature in which subtotal gastrectomy leaving the ulcer in situ had been done. There was one death. All patients were rendered achlorhydric and in all the ulcers promptly healed as indicated radiographically and by absence of symptoms.

In discussion **Richard H. Sweet,** Boston, expressed a preference for resection of the proximal portion of the stomach including the ulcer through the diaphragm by way of the intrathoracic approach. This precludes the hazard of leaving a misjudged carcinomatous ulcer.

**Radical Surgery in Cases of Calcification of the Pancreas, Allen O. Whipple,** New York.—The lesion of calcification of the pancreas is relatively rare. The cause of these calcific changes is not clear although previous attacks of acute pancreatitis or acute cholecystitis have been noteworthy in some cases.

The pathology in these patients varies considerably both as to the location and extent of the calcific changes, and the relation of these changes to the symptomatology. The amount of calcification around the ducts and the number of calculi in the ducts largely determines the number and size of associated cysts in these lesions. Whether previously developed areas of destroyed or damaged pancreatic tissue results in calcification is not clear; in some this seems to be the case. The extent of this calcific change does not necessarily determine the severity of symptoms. But in the patients operated upon pain has been the most marked and compelling symptom. This pain has been in the epigastrium, severe, fairly constant, radiating into the lower dorsal and upper lumbar region, made worse after eating, frequently so severe as to require opiates.

Physical signs are few or absent. There may be persistent tenderness along the pancreas. The diagnosis is based largely on the severe epigastric pain with the finding of patchy or nodular areas of calcification or calculi in a part or all the pancreas in the x-ray views of the upper abdomen. The removal of the part of the pancreas involved in the calcification, and in two instances a complete pancreatectomy, has resulted in relief of pain. If the head of the pancreas or all the pancreas has been removed, the duodenum has been excised, and in the cases of complete pancreatectomy, the spleen has also been removed. In these procedures a choledochojejunostomy and a gastrojejunostomy, as in the radical operation for carcinoma of the head of the pancreas, have been done.

A collected series of ten cases from several clinics was reported. After total pancreatectomy a surprisingly small quantity of insulin is required to maintain sugar metabolism.

In discussion **Alexander Brunschwig,** Chicago, stated that extensive calcification of the pancreas may exist with little or no symptoms.

**Results From Using Vitallium Tubes in Biliary Surgery, Herman E. Pearse,** Rochester, N. Y.—A follow-up study of 216 cases in which a vitallium tube was used to repair the common duct was reported. The majority of these data were obtained from correspondence with members of the American Surgical Association or their associates.

In 106 cases the vitallium tube was used to reconstruct the common bile duct. Of these, there were good results in 85 cases (80.1 per cent) and poor results in 12 cases (11.3 per cent) because of plugging of the tube. By analysis the material is largely bile pigment. If the tube plugs two or three years after its insertion, the duct reconstitutes to normal caliber. The tube may then be removed and the duct closed with good result.

In 79 cases the vitallium tube was used to anastomose the hepatic duct to the duodenum. There were good results in 46 cases (58.2 per cent) and poor results in 27 cases (34.1 per cent) because the tube was passed into the bowel. There were 18 cases in which the vitallium tube was used in anastomosing the hepatic duct to the jejunum. Of these, there were satisfactory results in 15 cases (83.3 per cent).

**Pancreatitis as a Cause of Complete Obstruction of the Common Bile Duct, J. Dewey Bisgard,** Omaha.—Reported were two cases of relatively painless jaundice with complete obstruction of the common bile duct in which it seemed probable that the jaundice resulted from temporary compression of the duct by swelling of the surrounding pancreatic tissue. No other etiology was demonstrated at operation and complete recovery followed surface drainage of the proximal common bile duct. Narrowing of the intrapancreatic portion of the duct was demonstrated by postoperative cholangiograms and subsequent progressive dilation was demonstrated in serial cholangiograms made through the indwelling T tube.

In discussion **I. S. Ravdin,** Philadelphia, stated that failure of filling of the distal portion of the common bile duct was indicative of spasm of the duct but he failed to explain how spasm can occur in the duct which has no muscle.

**Unusual Surgical Lesions of the Umbilicus, Carrington Williams,** Richmond, Va.—The conditions reported were the result of abnormal embryonic development either from persistence of an embryonic structure which should have disappeared or from faulty cleavage in the midline. The cases included cyst of the urachus, cyst of the vitelline duct, abscess of the urachus, hernia into the umbilical cord, amniotic hernia, eventration of the omentum, and primary carcinoma.

**Treatment of Bedsores by Total Excision and Primary Plastic Closure, James C. White,** Captain, and (by invitation) **William Hamm,** Captain, M.C., U.S.N.R.—With the protection of penicillin, decubitus ulcers can be resected and closed by primary suture. This permits rapid closure with full-thickness skin and early rehabilitation of patients with spinal paraplegia.

Adequate preliminary treatment is essential to combat anemia, hypoproteinemia, and avitaminosis. Bladder paralysis is treated by tidal irrigation; chemotherapy and surgical measures are used to clear up sepsis in the urinary tract and the tissues surrounding the decubitus.

The ulcer is then débrided and plastic skin flaps swung in for primary closure. A compression dressing is applied and penicillin given intramuscularly during the healing period.

Experience proved that clean healing was the rule. Hematomas or undue tension resulted in small defects which heal cleanly but more slowly. Within fourteen days, many of these lesions were firmly healed with well-padded movable skin covering the former defect.

**Primary Closure of Decubitus Ulcers, John H. Gibbons, Jr.,** Philadelphia, and (by invitation) **Leslie W. Freeman,** Captain, M.C., A.U.S.—World War II has left many hundreds of patients with paraplegia and the problem of treating their decubitus ulcers. Reported were sixty decubitus ulcers treated by complete excision of the ulcer, its margin, its base, and all pockets, followed by wide undermining, rotation of full-thickness skin flaps with attached subcutaneous tissue, and primary closure. Adequate nutrition is essential before operation. Preoperative levels of blood vitamin C, plasma protein, and hemoglobin were reported.

Important technical points are avoiding tension, using cotton sutures, and avoiding contamination of the wound during excision of the ulcer.

The results were: healed primarily, 37; healed in four weeks, 4; partial healing, improved, 5; complete failures, 3; too recent for comment, 11.

The conclusions were that spontaneous healing and skin grafting do not result in full-thickness skin and subcutaneous tissue over bony prominences. The treatment of choice in decubitus ulcers is radical excision and primary closure by rotation of the adjacent full-thickness skin flaps.

In discussion of the last two papers **Charles C. Lund,** Boston, stressed the importance of nutrition in these patients and outlined a diet containing skimmed milk, amigen, liver extract, and sugar containing 2,500 calories and 320 Gm. protein, fortified with vitamins. **Robert H. Ivy,** Philadelphia, expressed a preference for the technique described by **White** because in his technique the line of suture is not placed over the ulcer. **Robert H. Kennedy,** New York, remarked that a prompt dramatic improvement in appetite and nutrition follows closure. **James White,** Boston, suggested that the use of pyruvic acid for rapid removal of necrotic tissue would make it possible to close the ulcers earlier. **Gibbons** believes that it is not necessary to await closure of the ulcer until the wound is clean and the undermining has ceased.

**The Treatment of Acute Renal Failure by Peritoneal Irrigation, Jacob Fine,** Boston. —Renal damage following extensive muscle crush injury, incompatible blood transfusion,

sulfonamide hypersensitivity, and in other circumstances is not necessarily irreversible. Uremia can be treated successfully and death may be prevented during the period necessary for recovery of renal function, if the peritoneal cavity is utilized properly as a dialyzing membrane.

Through a tube of entrance leading into the upper part of the abdominal cavity and a tube of exit leading out of the pelvis, 20 L. or more of physiologic solution are circulated daily. If edema is present gelatine is added to the irrigating solution. Meticulous care is used to maintain asepsis and penicillin and sulfonamide drugs are used constantly to prevent peritonitis. Difficulty has been encountered in maintaining free circulation of the fluid through the peritoneal cavity.

Of five patients with renal shutdown in whom this procedure was used, one recovered. All showed a prompt drop of the blood nonprotein nitrogen to normal and maintenance of this normal level. In discussion **Arthur B. McGraw,** Detroit, reported a case in which this same procedure had been used with temporary benefit. **Alton Ochsner,** New Orleans, reported that Bliss had carried out the same procedure in nephrectomized animals and reported two patients who had been cured by lavage of the stomach with 20 L. of saline solution daily. **Jonathan E. Rhoads,** Philadelphia, presented a method by which the blood after heponizing the patient is circulated outside of the body through a circuit from artery to vein consisting of plastic tube immersed in a bath of a physiologic solution, the tube acting as a dialyzing membrane. **Ralph Colp,** New York, directed attention to a report from Holland of a device utilizing the same principle and similar to that described by Rhoads.

**Early Ambulation in Abdominal Surgery, John C. Burch,** and (by invitation) **H. C. Fisher,** Nashville, Tenn.—Early ambulation after abdominal operations affords a marked reduction in postoperative pulmonary and thromboembolic complications. In addition, there is a quicker return of normal bodily function as well as bladder and bowel functions. Early rising increases vital capacity, restores normal vascular tone and blood volume, and probably hastens wound healing.

In discussion **Bradley L. Coley,** New York, stated that among the patients treated in the hospitals in the Eighth Service Command where early ambulation was practiced there was 150 with phlebitis and 54 with pulmonary emboli.

**Resection of Abdominal Carcinomas Involving the Liver and Spleen Secondarily, Alexander Brunschwig** and (by invitation) **Douglas R. Morton,** Chicago.—Ten cases in which the primary neoplasms of abdominal viscera together with one or more hepatic metastases were excised were reported. Two patients were living and well four years after operation; others living shorter periods received palliation. It is probable that an individual develops some immunity to cancer.

In the discussion **Dallas B. Phemister,** Chicago, stated that the fact that these extensive operations were well tolerated when the circulation was maintained with the transfusion of adequate blood and fluid refuted the neurogenic theory of shock.

**Studies on Nutrition—The Effect of Preoperative Force Feeding on Surgical Patients, C. Everett Koop,** introduced by **Jonathan E. Rhoads,** Philadelphia.—A group of twenty-six patients undergoing major abdominal or intracranial operations were studied for the effect of preoperative hyperalimentation on the postoperative course. Eleven of these patients were force fed 0.9 Gm. of nitrogen per kilogram per day (about three times the normal postoperative requirement) for five preoperative days. The remaining fifteen patients served as controls. The response of the patients in the preoperative force fed group to the tilt table procedure suggested that their circulatory changes were somewhat less severe than those in the control group. Ballistocardiographic studies were made on all patients at comparable intervals pre- and postoperatively. These studies gave inconclusive results. The objective benefits of the program of preoperative force feeding were most noticeable in the group of neurosurgical patients undergoing craniotomy or craniectomy.

**Artriovenous Aneurysm of the Vertebral Vessels: Report of Eight Cases, Daniel C. Elkin,** Colonel, and (by invitation) **M. H. Harris,** Major, M.C., A.U.S.—Arteriovenous aneurysms of the extracranial portion of the vertebral vessels are rare. In a series of 450 cases of aneurysm and arteriovenous fistulas in an Army General Hospital, ten patients with this unusual lesion were encountered and all cured by operation. In cases previously reported there was a mortality of 50 per cent. These aneurysms are approached through an incision traversing the sternocleidomastoid muscle, exposing the transverse processes of the vertebrae at the level of the aneurysm. The vessels above and below are exposed by removing the overlying bone, and ligated proximally and distally.

**Rudolph Matas,** New Orleans, reported his experience with one case in which he opened the artery at the site of the aneurysm and plugged it with a small sea sponge. This controlled bleeding. The sea sponge absorbed and obliterated the aneurysm. **Wilder Penfield,** Montreal, Canada, reported a case in which he ligated the artery at the level of the fifth and sixth cervical vertebrae with no relief, therefore he ligated the proximal end through a cerebellar approach.

**Kymographic Observations of the Heart in the Presence of an Arteriovenous Fistula and Their Interpretation, Emile Holman,** San Francisco.—Kymographic studies with the fistula open and closed reveal a definite additional distention of an already dilated left ventricle and aorta on closing femoral and popliteal fistulas. This is the result of an abnormally increased blood volume in compensation for leakage through the fistula. The amount of increased blood volume and the corresponding changes in the heart are dependent upon the size of the fistula and this in turn is determined to some extent by the scar surrounding the fistula. After permanent surgical closure of the fistula, the increased blood volume shrinks to a normal level.

**The Surgical Treatment of Congenital Pulmonary Stenosis, Alfred Blalock,** and (by invitation) **Helen Taussig,** Baltimore.—Reported were ninety-one patients, between ages 5 months and 21 years, operated upon with a mortality of 23 per cent. All but one of the survivors showed improvement with disappearance of cyanosis and an increase in activity without dyspnea. Several resumed fairly normal activity. For the anastomosis the innominate, subclavian, and carotid arteries have been used. The subclavian artery is preferred because of hemoconcentration. Transfusions are seldom necessary. If not much blood is lost at operation some is withdrawn afterward. Several patients developed hemiplegia but the majority of these cleared.

**Allen Whipple,** New York, commended the authors for opening a new important field in surgery. **Claude Beck,** Columbus, Ohio, stated that funds were available for research in cardiovascular disease. **Emile Holman,** San Francisco, reported two cases. In one the common carotid artery was mobilized in the neck and brought down into the chest to anastomose to the pulmonary artery. A hemiplegia developed in five days.

**Arterial Repair in the Treatment of Aneurysms and Arteriovenous Fistulas With a Report of Twenty Successful Restorations, Norman E. Freeman,** Philadelphia.—In case that a large defect in the arterial wall is present, lateral suture may restrict the lumen of the vessel. With transvenous repair, a possible second perforation of the artery may be overlooked. In order to overcome these objections the following technique has been developed. After control of the component vessels, the artery is cut from the vein. The opening into the latter is closed by a running suture. The damaged portion of the arterial wall is then excised and the defect closed transversely.

Arterial repairs, the greater number by transverse suture, were performed in twenty-four cases of aneurysms and arteriovenous fistulas. Success of the repair was demonstrable in twenty of the twenty-four cases.

The following arteries were successfully repaired: Abdominal aorta, 1; common carotid, 2; subclavian, 2; brachial, 2; superficial femoral, 6; popliteal, 7.

**Daniel C. Elkin,** Emory University, Ga., stated that in 800 cases with quadruple ligation, gangrene of the extremities developed in only two cases. Twelve patients subse-

quently had intermittent claudication. In eighteen cases in which restorations were performed, there was one failure and two cases with subsequent claudication. **Rudolph Matas,** New Orleans, said that an effort should always be made to preserve the carotid, popliteal, and femoral arteries above the profunda in continuity. **Isaac Bigger,** Richmond, Va., pointed out that a diminution in circulation develops later.

**Surgical Treatment of Angina Pectoris; Experiences With Ligation of the Great Cardiac Vein and Pericoronary Neurectomy, Mercier Fauteux,** introduced by **Elliott C. Cutler,** Boston.—Two essential objectives must be attained for alleviation of symptoms and improvement of cardiac circulation: (1) abolition of reflexes which produce coronary spasm, ventricular fibrillation, and anginal pain; (2) acceleration of the natural mechanisms which cause establishment of compensatory circulation and development of an efficient collateral circulation.

Experimental studies demonstrated that the first objective can be obtained by pericoronary neurectomy, and the second by ligation of the great cardiac vein. Both procedures must be accomplished to give maximum benefit to the patient. Fifteen patients operated upon during the past six years were reported upon.

# Book Reviews

**Clinical Traumatic Surgery.** By John J. Moorhead, B.S., M.D., D.Sc., F.A.C.S. (D.S.M.), Columbia University, New York, N. Y. Pp. 747, with 500 illustrations. Philadelphia, 1945, W. B. Saunders Company.

This recently published book is the best of its kind available. As the author states in his preface, the aim has been to place in one volume all the information necessary to diagnose and treat the usual and most of the unusual effects of accident and trauma. In large measure this aim has been achieved and all those physicians and surgeons whose practice includes any appreciable number of industrial or emergency cases will want to possess a copy. Being written by one man, the book contains both defects and assets. The opinions expressed are the personal ones of the writer and not necessarily the accepted opinions of the profession.

The writer was by chance in Pearl Harbor when World War II broke out and gives the impression that this book contains those lessons in surgery learned during the past war. As a matter of fact, however, the author's experience in the past war must have been transient and fairly casual for the ideas expressed concerning military surgery are those with which we entered the war and not those which we learned during the war or with which we ended the war. To the reviewer, this attempt to impart a military flavor to the work, excellent in its own right, is unfortunate and inaccurate. In substance the book incorporates the long experience of the Medical Director of the New York City Transit System and its predecessors, but little else.

Approximately one-third of the book is devoted to subjects usually considered to fall within the domain of treatises dealing with orthopedic conditions. A surprisingly detailed and lengthy account of fractures and joint conditions is given.

Chapters of exceptional merit on those interphases between medicine and the law have been included. The titles of these chapters are as follows: Relation of Trauma to Appendicitis, Abortion and Visceral Displacement, Traumatic Neuroses, Medicolegal Phases of Trauma, Compensation Problems, and Malpractice Suits. For the surgeon doing any appreciable amount of industrial work these chapters alone would be well worth the price of the book.

This book, in a sense like all other books on modern surgery, is obsolete by the time it has been published. The author's emphasis on the use of the sulfonamide drugs in various conditions is not in keeping with present-day opinion. A short mention of penicillin is made, but none of the experience with this drug now available in the literature has been included. The 500 illustrations with which the book is filled include diagrams, photographs, and drawings. These are well done.

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**Diseases of the Nervous System in Infancy, Childhood and Adolescence.** Second Edition by Frank R. Ford, M.D., Associate Professor in Neurology, Johns Hopkins University. Pp. 1,143, with 164 illustrations. Springfield, Ill., 1945, Charles C Thomas, Publisher.

This book is one of the most complete single volumes written on the subject of neurology. The author has covered in detail the various diseases of the nervous system, including many of the rarest conditions, and still has maintained a style of simplicity and brevity which allows for easy readability.

The discussion of the actual disease conditions is preceded by a very comprehensive but brief review of the clinical aspects of the anatomy and physiology of the nervous system. In

this chapter the author has included a brief summary of many of the clinical syndromes resulting from various peripheral nerve and cerebral vascular involvements. These should prove of utmost value to the reader when quick orientation is desired. In his discussion of the prenatal diseases of the nervous system, the author has included many rare forms of congenital defects, thus compiling an actual encyclopedia of rare conditions. In the section on the infections are included such rare conditions as the involvement of the nervous system in epidemic hiccough, leprosy, *Toxoplasma*, and trypanosomiasis. The author's grouping in this section is a little unusual in that the suppurative and the nonsuppurative infections are discussed together and no sharp separation is made in the discussion of the encephalitides from the discussion of the meningitides. The chapter on brain tumors has been so arranged that the various lesions are taken up by cerebral location rather than by histologic type. This enables the author to summarize the clinical symptoms resulting from focal involvement of the brain and at the same time to discuss briefly the gross characteristics of some of the more common intracranial tumors.

The book is concluded with a brief description of the more common neurologic syndromes as an aid to the doctor in differential diagnosis. The entire text is amazingly well illustrated and has a large bibliography. Well selected case studies have been included to clarify the clinical material.

Because of the completeness with which the author has covered his subject, this work obviously is best suited as a reference book since it is much too detailed for the routine use of the student. As a reference book, it is one of the finest in the field of neurology and can be highly recommended to the neurologist, the neurosurgeon, the pediatrician, as well as the internist.

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**The Intervertebral Disc.** By F. Keith Bradford, M.D., Houston, Texas, and R. Glen Spurling, M.D., Louisville, Kentucky. Pp. 192, with 70 illustrations. Springfield, Ill., 1945, Charles C Thomas, Publisher. $4.

Since the first edition of this book was published in 1941, it has become well known to those who are interested in herniated intervertebral discs. This second edition is a summary of the voluminous literature which has accumulated in the last ten years concerning the embryology, anatomy, physiology, pathology and clinical importance of the intervertebral disc.

The authors' appraisal is a fairly conservative and reliable guide, which should be especially useful for those who are not operating on a large number of these patients and who, for this reason, cannot make accurate evaluations of the various phases of the disc syndrome. Almost everyone who sees a large number of these patients will disagree with some of the points presented, but most will agree with the general scope of the book.

It is inevitable that certain changes should be made in this new edition inasmuch as five years have elapsed since the first edition was published. The authors now believe that pantopaque is the best contrast media for spinograms and advise its use instead of air, which they advised in the first edition. This change to pantopaque is apparently a result of the refinements made in the interim in technique for removal of oil injected into the subarachnoid space. A slightly more limited laminectomy is now advised for removal of discs at the fourth lumbar interspace, and some refinements have been added in methods of examination of patients for disc lesions. It is obvious that the authors have shifted a little further toward the opinion that hypertrophy of the ligamentum flavum is not a cause of low back and sciatic pain. They now say that it is an extremely rare cause of such pain.

There is a very timely section of some eight pages on the subject of lateral cervical herniation added in this edition. This type of herniation has become increasingly important in the last few years.

What seems to be inconsistency in the first edition is repeated in the second edition when on page 35 it is stated that it is not likely that the lateral herniations present be-

neath the posterior longitudinal ligament, but on page 91 the herniation is spoken of as having ruptured completely through the posterior longitudinal ligament and lying free in the spinal canal.

The statement that "the correct diagnosis is now made clinically in about 80 per cent of patients having herniation of the nucleus pulposus" is certainly open to question, since no proof is offered to support this optimistic statement.

The importance of functional disease in the differential diagnosis of low back and sciatic pain would seem to warrant more than a comment that "the *experienced observer* will not be deceived in the identification of the symptoms and signs of a true sciatic pain." This misleading statement may lead to many unnecessary operations on patients with symptoms and signs simulating disc lesions, but the etiology of which is functional.

Although inadequacies are present in the book, they are few, and it is an excellent summary of the problem. The book deserves careful consideration by all those interested in the herniated intervertebral disc.

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**Bone Grafting in the Treatment of Fractures.** By J. R. Armstrong, M.D., M.Ch., F.R.C.S. Baltimore, 1945, Williams & Wilkins Company. $7.

This monograph on bone grafting in the treatment of fractures covers nearly all types of nonunion. The techniques, on a whole, are good; preoperative and postoperative care is rightly stressed and the proper selection of cases is discussed. General principles of bone grafting are concisely presented. Most modern grafting techniques, with some modifications, are described. One type not described which has found a useful place in this country is the combination of a plate with a graft, either of cortical or cancellous bone. In some illustrations, fixation seems inadequate as only one screw is used in each end of a graft.

Exception may be taken to the time during which a tourniquet is allowed to remain on an extremity. On the arm, the time allowance stated is up to two and one-half hours and on the leg, up to three hours. Tourniquet palsies may result if tourniquets are in place for this length of time. The text also advocates that the tourniquet remain on until after the wound has been closed and a cast or dressing applied. Preferably, one should release the tourniquet, catch bleeders, and then close the wound. Hematomas and subsequent infections can result if bleeding points are not secured.

Aside from the aforementioned objections, the book may be highly recommended. The techniques and the illustrations are good.

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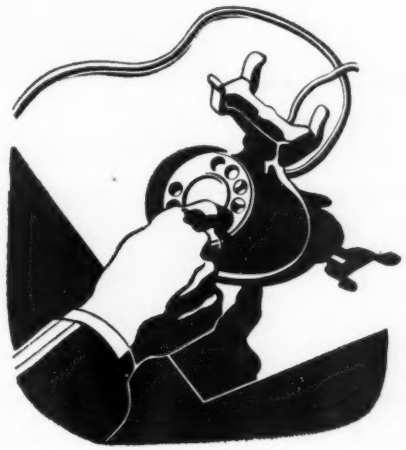

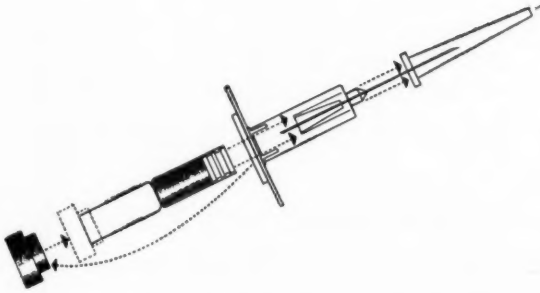

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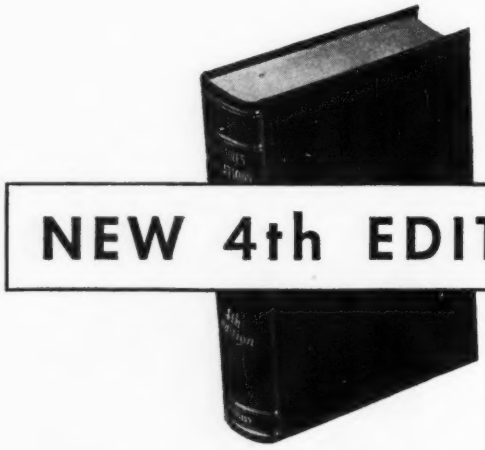

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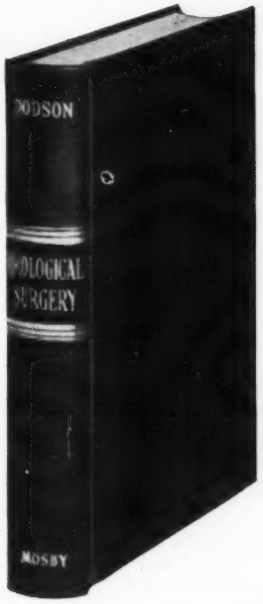


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Gomco Surgical Manufacturing Corp. (Thermotic Pump) ---------- 6

Hoffmann-La Roche, Inc. (Allonal) ---------- Fourth Cover

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Lippincott Company, J. B. (Surgical Books) ---------- 15

National Drug Company, The (Aminonat) ---------- 1

National Foundation for Infantile Paralysis, The ---------- 20

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Singer Sewing Machine Company (Surgical Stitching Instruments) ---------- 5

Stearns & Company, Frederick (Fergon) ---------- 3

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